DOCUMENT RESUME

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TITLE Military Curriculum Materials for Vocational and Technical Education. Masonry Specialist III & IV, 3-20.

INSTITUTION Air Force Training Command, Sheppard AFB, Tex.; Ohio State Univ., Columbus. National Center for Research in Vocational Education.

SPONS AGENCY Office of Vocational and Adult Education (ED), Washington, DC.

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DESCRIPTORS Behavioral Objectives; *Bricklaying; *Building Trades; Construction (Process); *Construction Materials; Instructional Materials; *Learning Modules; Lesson Plans; *Masonry; Military Personnel; Military Training; Postsecondary Education; Skilled Occupations; Study Guides; Workbooks

IDENTIFIERS *Cement; Military Curriculum Project; *Plasters; Tile Occupations

ABSTRACT

These military-developed curriculum materials consist of a course description, plan of instruction, study guides, and workbooks for use in training masonry specialists. Covered in the course blocks are laying concrete blocks, stone, and bricks as well as plaster, stucco, and tile. Course block III, on laying concrete blocks, stone, and bricks, deals with cutting masonry, concrete block construction, brick construction, and maintenance and repair of masonry structures. Addressed in course block IV, on plaster, stucco, and tile, are applying plaster and stucco and installing wall and floor tile. (MN)

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This military technical training course has been selected and adapted by The Center for Vocational Education for "Trial Implementation of a Model System to Provide Military Curriculum Materials for Use in Vocational and Technical Education," a project sponsored by the Bureau of Occupational and Adult Education, U.S. Department of Health, Education, and Welfare.

MILITARY CURRICULUM MATERIALS

The military-developed curriculum materials in this course package were selected by the National Center for Research in Vocational Education Military Curriculum Project for dissemination to the six regional Curriculum Coordination Centers and other instructional materials agencies. The purpose of disseminating these courses was to make curriculum materials developed by the military more accessible to vocational educators in the civilian setting.

The course materials were acquired, evaluated by project staff and practitioners in the field, and prepared for dissemination. Materials which were specific to the military were deleted, copyrighted materials were either omitted or approval for their use was obtained. These course packages contain curriculum resource materials which can be adapted to support vocational instruction and curriculum development.

The National Center Mission Statement

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Military Curriculum Materials
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Military Curriculum Materials for Vocational and Technical Education

Information and Field Services Division

The National Center for Research in Vocational Education

Military Curriculum Materials Dissemination Is . . .

an activity to increase the accessibility of military developed curriculum materials to vocational and technical educators.

This project, funded by the U.S. Office of Education, includes the identification and acquisition of curriculum materials in print form from the Coast Guard, Air Force, Army, Marine Corps and Navy.

Access to military curriculum materials is provided through a "Joint Memorandum of Understanding" between the U.S. Office of Education and the Department of Defense.

The acquired materials are reviewed by staff and subject matter specialists, and courses deemed applicable to vocational and technical education are selected for dissemination.

The National Center for Research in Vocational Education is the U.S. Office of Education's designated representative to acquire the materials and conduct the project activities.

Project Staff:

Wesley E. Budke, Ph.D., Director
National Center Clearinghouse

Shirley A. Chase, Ph.D.
Project Director

What Materials Are Available?

One hundred twenty courses on microfiche (thirteen in paper form) and descriptions of each have been provided to the vocational Curriculum Coordination Centers and other instructional materials agencies for dissemination.

Course materials include programmed instruction, curriculum outlines, instructor guides, student workbooks and technical manuals.

The 120 courses represent the following sixteen vocational subject areas:

- Agriculture
- Aviation
- Building & Construction Trades
- Clerical Occupations
- Communications
- Drafting
- Electronics
- Engine Mechanics
- Food Service
- Health
- Heating & Air Conditioning
- Machine Shop
- Management & Supervision
- Meteorology & Navigation
- Photography
- Public Service

The number of courses and the subject areas represented will expand as additional materials with application to vocational and technical education are identified and selected for dissemination.

How Can These Materials Be Obtained?

Contact the Curriculum Coordination Center in your region for information on obtaining materials (e.g., availability and cost). They will respond to your request directly or refer you to an instructional materials agency closer to you.

CURRICULUM COORDINATION CENTERS

EAST CENTRAL
Rebecca S. Douglass
Director
100 North First Street
Springfield, IL 62777
217/782-0759

NORTHWEST
William Daniels
Director
Building 17
Airdustrial Park
Olympia, WA 98504
206/753-0879

MIDWEST
Robert Patton
Director
1515 West Sixth Ave.
Stillwater, OK 74704
405/377-2000

SOUTHEAST
James F. Shill, Ph.D.
Director
Mississippi State University
Drawer DX
Mississippi State, MS 39762
601/325-2510

NORTHEAST
Joseph F. Kelly, Ph.D.
Director
225 West State Street
Trenton, NJ 08625
609/292-6562

WESTERN
Lawrence F. H. Zane, Ph.D.
Director
1776 University Ave.
Honolulu, HI 96822
808/948-7834

MASONRY SPECIALIST, III AND IV

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Developed by:
United States Air Force

Development and Review Dates:
August 15, 1974

D.O.T. No.:
859.884

Occupational Area:
Building and Construction

Target Audiences:
Grades 10-adult

Print Pages:
210

Cost:
$4.25

Availability:
Military Curriculum Project, The Center for Vocational Education, 1960 Kenny Rd., Columbus, OH 43210

Contents:	Type of Materials:								Instructional Design:					Type of Instruction:		
	Lesson Plans:	Programmed Text:	Student Workbook:	Handouts:	Text Materials:	Audio-Visuals:	Performance Objectives:	Tests:	Review Exercises:	Additional Materials Required:	Group Instruction:	Individualized:	
			No. of pages										
Block III – *Laying Concrete Block, Stone, and Brick*			33					*					
Cutting Masonry	•		•		•		•				•		
Concrete Block Construction	•		•		•		•				•		
Stone Construction	•		•		•		•				•		
Brick Construction	•		•		•		•				•		
Maintenance and Repair of Masonry Structures	•		•		•		•				•		
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Applying Plaster and Stucco	•		•		•		•				•		
Installing Wall and Floor Tile	•		•		•		•				•		

* Materials are recommended but not provided.

Expires July 1, 1978

Course Description

This course is the second course in a two course series designed to provide instruction in the following areas: an introduction to masonry; hand, portable power, and shop tools; construction and maintenance of masonry structures using clay, brick, concrete block, stone, and tile; preparation of concrete, mortar, and plaster mixes; placement of reinforcement steel; and the placement and finishing of concrete. This course, **Masonry Specialist, III and IV**, consists of two blocks totaling 118 hours of instruction. **Masonry Specialist, I and II** (course 3-19 in this catalog) contains two blocks: (Block I) *Introduction to Masonry* and (Block 2) *Rigid Concrete Structures*, totaling 94 hours of instruction. Students should complete course 3-19 or the equivalent before beginning this second course.

Block III – *Laying Concrete Block, Stone, and Brick* contains five lessons totaling 64 hours of instruction.

Cutting Masonry (6 hours)
Concrete Block Construction (18 hours)
Stone Construction (12 hours)
Brick Construction (24 hours)
Maintenance and Repair of Masonry Structures (4 hours)

Block IV – *Plaster, Stucco, and Tile* contains two lessons totaling 54 hours of instruction. A third section was deleted because it deals with military security.

Applying Plaster and Stucco (27 hours)
Installing Wall and Floor Tile (27 hours)

The course contains materials for both student and teacher use. Printed materials for the instructor include a plan of instruction for each block and lesson plans for each lesson. These contain an outline of instruction, objectives, activities, materials and tools needed, text assignments, and references. Student materials consist of study guides and workbooks for each block. Seven transparency sets are suggested for use but are not provided.

PLAN OF INSTRUCTION/LESSON PLAN PART I

NAME OF INSTRUCTOR	COURSE TITLE: Masonry Specialist
BLOCK NUMBER: III	BLOCK TITLE: Laying Concrete Block, Stone, and Brick

1 COURSE CONTENT	2 DURATION (Hours)
1. Cutting Masonry	6 (6/0) Day 20
a. Working as a member of a four-man team and using a brick hammer, brick set, trowel, and masonry saw, cut and shape bricks, blocks, and stone as specified in the instructions provided. All bricks, blocks, and stone must be cut correctly. STS 6a(2), 11a(1), 11a(2), 11a(3), 11a(4), 12a(1), 12a(2), 12a(3), 12a(4), 13a(1), 13a(2), 13a(3), 13a(4). Meas: W, PC	(6/0)
(1) Masonry tools and equipment	
(2) Materials used in masonry construction	
(3) Cutting masonry materials	
(4) Safety precautions	
3-20	

SUPERVISOR APPROVAL OF LESSON PLAN (PART II)

SIGNATURE	DATE	SIGNATURE	DATE

PLAN OF INSTRUCTION NO.	DATE	PAGE NO.
3ABR55233	12 November 1975	41

ATC FORM APR 74 133 REPLACES ATC FORMS 337, MAR 73, AND 770, AUG 72, WHICH WILL BE USED.

PLAN OF INSTRUCTION/LESSON PLAN PART I (Continuation Sheet)

COURSE CONTENT

SUPPORT MATERIALS AND GUIDANCE

Student Instructional Materials
SG 3ABR55233-III-1, Cutting Masonry
WB 3ABR55233-III-1-P1, Cutting Masonry Material

Audio Visual Aids
Transparencies, Cutting Masonry

Training Equipment
Masonry Saw (12)
Power Mortar Mixer (12)
Hand Tools for Cutting Masonry (2)

Training Methods
Discussion (1 hr)
Demonstration (1 hr)
Performance (4 hrs)

Multiple Instructor Requirements
Supervision (2)

Instructional Guidance
Identify and name the various tools, equipment, and materials used in masonry instruction. Divide the class into three groups and have them cut and shape various types of masonry materials.

The following references should be used when preparing the lesson: CDC 55233, Apprentice Mason, and AFP 88-27, Civil Engineer Handbook.

MIR: The class will be divided into three groups for the performance. Two instructors will be required to supervise these three groups.

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PLAN OF INSTRUCTION/LESSON PLAN PART I

NAME OF INSTRUCTOR	COURSE TITLE: Masonry Specialist
BLOCK NUMBER: III	BLOCK TITLE: Laying Concrete Block, Stone, and Brick

1 COURSE CONTENT	2 DURATION (Hours)
2. Concrete Block Construction	24 (18/6) Days 21, 22, and 23
a. Given a sketch of a masonry project, estimate the number of concrete blocks and the amount of mortar required to complete the project. Estimations must be within -0% + 10%. STS 7a and 7c. Meas: W, PC	(1.5/1)
(1) Block size	
(2) Block shape	
(3) Types of block	
(4) Volume of mortar	
(5) Estimating procedures	
b. Working as a member of a four-man team and using specific tools, materials, and instructions provided, lay out a site for a one-story, concrete block, masonry structure. The site must be ready for the construction of the building. STS 7a and 7b. Meas: W, PC	(1.5/1)
(1) Modular design	
(2) Story pole	
(3) Bonds	
(4) Layout procedures	

SUPERVISOR APPROVAL OF LESSON PLAN (PART II)

SIGNATURE	DATE	SIGNATURE	DATE

PLAN OF INSTRUCTION NO.	DATE	PAGE NO.
3ABR55233	12 November 1975	43

ATC FORM APR 75 133 REPLACES ATC FORMS 337, MAR 73, AND 770, AUG 72, WHICH WILL BE USED.

COURSE CONTENT

c. Working individually, but as a member of a two-man team, use concrete blocks and construct a corner for a one-story masonry building. The finished work must be within 1/4 inch of proper height and 1/4 inch of being plumb. STS 12b, 12c, and 12d Meas: W, PC (9/2)

(1) Preparing mortar

(2) Surface and bed for mortar

(3) Applying mortar

(4) Positioning blocks

(5) Horizontal and vertical alignment

(6) Shaping mortar joints

d. Working as a member of a two-man team, construct a block wall for a one-story masonry structure. The finished wall must be within 1/4 inch of proper height and 1/4 inch of being plumb. STS 12c, 12e(1), 12e(2), 12e(3), 12f, and 12g. Meas: W, PC (6/2)

(1) Mason lines

(2) Spreading mortar

(3) Laying block to a line

(4) Metal ties

(5) Inspecting completed work

SUPPORT MATERIALS AND GUIDANCE

Student Instructional Materials
SG 3ABR55233-III-2, Concrete Block Construction
WB 3ABR55233-III-2-P1, Estimating Concrete Block Construction
WB 3ABR55233-III-2-P2, Laying Out a Site for a Concrete Block Wall
WB 3ABR55233-III-2-P3, Constructing a Concrete Block Wall
CDC 55233, Apprentice Mason

Audio Visual Aids
Transparencies, Concrete Block Construction
Training Film: FLC 1/256, ABCs of Masonry Construction

Training Equipment
Mortar Mixer (12)
Mortar Box (12)
Hand Tools for Concrete Block Construction (2)

Training Methods
Discussion (3 hrs)
Demonstration (2 hrs)
Performance (13 hrs)
Outside Assignment (6 hrs)

Multiple Instructor Requirements
Supervision (2)

Instructional Guidance
Discuss and demonstrate the methods of laying out and constructing a concrete block wall. For criterion objective 2b, divide the class into three groups and have each group lay out a site for a one story masonry structure. For criterion objectives 2c and 2d, divide the class into six groups and have each group build a concrete block wall. The following references should be used when preparing the lesson: CDC 55233, Apprentice Mason, and AFP 88-27, Civil Engineer Handbook

Make the following outside assignments: For day 21, have the students study SG 3ABR55233-III-2. For day 22, have the students study chapter 5 in CDC 55233. For day 23, have the students review all the material covered in this unit of instruction.

MIR: The class will be divided into three groups for criterion objective 2b. Two instructors will be required to supervise these three groups. The class will be divided into six groups for criterion objectives 2c and 2d. Two instructors will be required to supervise these six groups.

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PLAN OF INSTRUCTION/LESSON PLAN PART I

NAME OF INSTRUCTOR	COURSE TITLE: Masonry Specialist
BLOCK NUMBER: III	BLOCK TITLE: Laying Concrete Block, Stone and Brick

1 COURSE CONTENT	2 DURATION (Hours)
3. Stone Construction	16 (12/4) Days 24 and 25
a. Given the construction drawing of a stone wall, estimate the amount of store and mortar required to complete the project. Estimations must be within -0% + 10%. STS 7a and 7c. Meas: W, PC	(1.5/1)
(1) Stone size	
(2) Stone shape	
(3) Types of stone	
(4) Volume of mortar	
(5) Estimating procedures	
b. Working as a member of a four-man team and using specific tools, materials, and instruction provided, lay out a site for a stone wall. The site must be ready for the construction of the wall. STS 7a and 7b. Meas: W, PC	(1.5/1)
(1) Foundations	
(2) Header stone	
(3) Bonds	
(4) Layout procedures	

SUPERVISOR APPROVAL OF LESSON PLAN (PART II)

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ATC FORM APR 75 133 REPLACES ATC FORMS 337, MAR 73, AND 770, AUG 72, WHICH WILL BE USED.

c. Working individually, but as a member of a team and following instructions, construct a stone wall for a one-story masonry building. The completed wall must comply with good masonry practices and be within 1/2 inch of proper height and 1/4 inch of being plumb. STS 13b, 13c, 13d, 13e(1), 13e(2), 13e(3), 13f. Meas: W, PC (9/2)

(1) Preparing mortar

(2) Surface and bed for mortar

(3) Applying mortar

(4) Positioning stone

(5) Horizontal and vertical alignments

(6) Installing anchor and rock bolts

(7) Shaping mortar joints

SUPPORT MATERIALS AND GUIDANCE

Student Instructional Materials
SG 3ABR55233-III-3, Stone Construction
WB 3ABR55233-III-3-P1, Estimating Stone Construction
WB 3ABR55233-III-3-P2, Laying Out a Stone Wall
WB 3ABR55233-III-3-P3, Constructing a Stone Wall
CDC 55233, Apprentice Mason

Audio Visual Aids
Transparencies, Stone Construction

Training Equipment
Mortar Mixer (12)
Mortar Box (12)
Hand Tools for Stone Construction (2)

Training Methods
Discussion (1 hr)
Demonstration (1 hr)
Performance (10 hrs)
Outside Assignment (4 hrs)

Multiple Instructor Requirements
Supervision (2)

Instructional Guidance
Discuss and demonstrate the methods of laying out and constructing a stone wall. For criterion objectives 3b and 3c, divide the class into three groups and have each group lay out a site and construct a stone wall. The following references should be used when preparing the lesson: CDC 55233, Apprentice Mason, and AFP 88-27, Civil Engineering Handbook.
Make the following outside assignment:
For day 24, have the students study SG 3ABR55233-III-5 and answer the questions at the end of the text.
For day 25, have the students read paragraph 18, chapter 5 in CDC 55233.

MIR: The class will be divided into three groups for criterion objectives 3b and 3c. Two instructors will be required to supervise these three groups.

PLAN OF INSTRUCTION/LESSON PLAN PART I

NAME OF INSTRUCTOR	COURSE TITLE
	Masonry Specialist

BLOCK NUMBER	BLOCK TITLE
III	Laying Concrete Block, Stone, and Brick

1 COURSE CONTENT	2 DURATION (Hours)
4. Brick Construction	32 (24/8) Days 26, 27, 28, and 29
a. Using a construction drawing of a masonry project, determine the number of bricks and the amount of mortar required to complete the project. Estimation must be within -0% + 10%. STS 7a and 7c. Meas: W, PC	(1.5/1)
(1) Brick size	
(2) Brick position	
(3) Quantities of brick	
(4) Volume of mortar	
b. Working as a member of a four-man team, and following given directions, lay out the site for a one-story brick building. Indicate the location and size of the window and door openings. All measurements must be within ± 1/4 inch of given specifications STS 7a. Meas: W, PC	(1.5/1)
(1) Modular design	
(2) Story pole	
(3) Bonds	
(4) Layout procedures	

SUPERVISOR APPROVAL OF LESSON PLAN (PART II)

SIGNATURE	DATE	SIGNATURE	DATE

PLAN OF INSTRUCTION NO.	DATE	PAGE NO.
3ABR55233	12 November 1975	51

ATC FORM APR 75 133 REPLACES ATC FORMS 337, MAR 73, AND 770, AUG 72, WHICH WILL BE USED.

PLAN OF INSTRUCTION/LESSON PLAN PART I (Continuation Sheet)

COURSE CONTENT

c. Working individually, but as a member of a four-man team, use brick and construct a corner for a one-story masonry building. The finished work must be within 1/4 inch of proper height and 1/4 inch of being plumb. STs 11b, 11c, 11d, 11e(1), 11e(2), 11e(3) and 12c. Meas: W, PC (9/2)

(1) Preparing mortar

(2) Surface and bed for mortar

(3) Applying mortar

(4) Positioning bricks

(5) Horizontal and vertical alignments

(6) Shaping mortar joints

d. Working individually, but as a member of a team, construct a brick wall for a one-story, masonry structure. The finished wall must be within 1/4 inch of proper height and 1/4 inch of being plumb. STS 11b, 11c, 11d, 11e(1), 11e(2), 11e(3), 11f, 11g, and 12c Meas: W, PC (14/4)

(1) Mason lines

(2) Clean surface and prepare bed for mortar

(3) Spreading mortar

(4) Laying bricks to a line

(5) Metal ties

(6) Inspecting completed work

SUPPORT MATERIALS AND GUIDANCE

Student Instructional Materials
SG 3ABR55233-III-4, Brick Construction
WB 3ABR55233-III-4-P1, Estimating Brick Construction
WB 3ABR55233-III-4-P2, Laying Out a Brick Wall
WB 3ABR55233-III-4-P3, Constructing a Brick Wall
CDC 55233, Apprentice Mason

Audio Visual Aids
Transparencies, Brick Construction
Training Film: FLC 5/125, Elements of Brickwork

Training Equipment
Mortar Mixer (12)
Mortar Box (12)
Hand Tools for Brick Construction (2)

Training Methods
Discussion (4 hrs)
Demonstration (4 hrs)
Performance (16 hrs)
Outside Assignment (8 hrs)

Multiple Instructor Requirements
Supervision (2)

Instructional Guidance
For day 26, discuss and demonstrate how to lay out and construct a brick building. For criterion 4a, have the students complete WB 3ABR55233-III-4-P1. For criterion 4b, divide the class into three teams and have them complete WB 3ABR55233-III-4-P2. For criterion objectives 4c and 4d, have the students complete WB 3ABR55233-III-4-P3.
Make the following outside assignments:
For day 26, have the students read paragraph 14, chapter 4, in CDC 55233.
For day 27, have the students read paragraph 15, chapter 4 in CDC 55233.
For day 28, have the students study SG 3ABR55233-III-4 and answer the questions at the end of the text. For day 29, have the students review all the materials covered in this unit of instruction.
The following references should be used when preparing the lesson: CDC 55233, Apprentice Mason, and AFP 88-27, Civil Engineer Handbook.

MIR: The class will be divided into three groups for the performance. Two instructors will be required to supervise these three groups.

PLAN OF INSTRUCTION/LESSON PLAN PART I

NAME OF INSTRUCTOR	COURSE TITLE
	Masonry Specialist

BLOCK NUMBER	BLOCK TITLE
III	Laying Concrete Block, Stone and Brick

1 COURSE CONTENT	2 DURATION (Hours)
5. Maintenance and Repair of Masonry Structures	6 (4/2) Day 30
a. Following given directions, inspect, clean, and repair joints and cracks in a masonry wall. All joints must be repaired correctly. STS 11h, 11j, 12h, 12j, 13g, 13h. Meas: W, PC	(2/1)
(1) Inspection methods and procedures	
(2) Removal of damaged joint or section	
(3) Mixing mortar to match existing wall joints	
(4) Repairing cracks and joints	
(5) Methods of cleaning mortar stains from masonry surfaces	
b. Following given directions, apply waterproofing and dampproofing materials to masonry structures. The surface must be completely covered with no visible voids. STS 11i, 12i. Meas: W, PC	(2/1)
(1) Basement walls	
(2) Exposed exterior walls	

SUPERVISOR APPROVAL OF LESSON PLAN (PART II)

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ATC FORM APR 75 133 REPLACES ATC FORMS 337, MAR 73, AND 771, AUG 72, WHICH WILL BE USED.

PLAN OF INSTRUCTION/LESSON PLAN PART I (Continuation Sheet)

COURSE CONTENT

SUPPORT MATERIALS AND GUIDANCE

Student Instructional Materials
SG 3ABR55233-III-5, Maintenance and Repair of Masonry Structures
WB 3ABR55233-III-5-P1, Inspecting, Cleaning, and Repairing Masonry Surfaces
WB 3ABR55233-III-5-P2, Applying Waterproofing and Dampproofing Materials
CDC 55233, Apprentice Mason

Audio Visual Aids
Transparencies, Maintenance and Repair of Masonry Structures

Training Equipment
Hand Tools for Repair of Masonry Structures (2)

Training Methods
Discussion (1 hr)
Demonstration (1 hr)
Performance (2 hrs)
Outside Assignment (2 hrs)

Multiple Instructor Requirements
Supervision (2)

Instructional Guidance
Discuss and demonstrate how to inspect, clean, and repair cracks and joints in concrete blocks, stone and brick surfaces. Divide the class into two groups and have them complete Workbooks 3ABR55233-III-5-P1 and P2. Make the following outside assignment: For day 30 have the students study SG 3ABR55233-III-5 and review all the materials covered in this block.
The following references should be used when preparing the lesson: CDC 55233, Apprentice Mason, and AFP 88-27, Civil Engineer Handbook.

MIR: The class will be divided into two groups for the performance and each group will require one instructor.

6. Related Training (identified in the course chart) 2

7. Measurement Test and Test Critique 2

   a. Measurement Test

   b. Test Critique

PLAN OF INSTRUCTION NO.	DATE	PAGE NO.
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PERI ACES AFC FORMS 3274, MAR 73, AND 3274A, AUG 73, WHICH WILL BE

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PLAN OF INSTRUCTION/LESSON PLAN PART I

NAME OF INSTRUCTOR	COURSE TITLE
	Masonry Specialist

BLOCK NUMBER	BLOCK TITLE
IV	Plaster, Stucco, and Tile

1 COURSE CONTENT	2 DURATION (Hours)
1. Applying Plaster and Stucco	35 (27/8) Days 31 thru 34 and half of Day 35
a. Working individually, but as a member of a team and using given instructions, lay out a lath surface for plaster or stucco. Surface must be ready for a scratch coat of plaster. STS 7a, 9a(3). Meas: W, PC	(6/2)
(1) The uses and advantages of plaster and stucco	
(2) Plaster and stucco mixtures	
(3) "Setting up" characteristics of plaster and stucco	
(4) Layout and application tools	
(5) Installation of lath	
(6) Thickness references	
b. Working individually, but as a member of a team and using given instructions, mix and apply a scratch coat of plaster. Surface must be completely covered with no visible voids and be ready for a brown coat of plaster. STS 9a(2), 9c(1), 9d, and 9f. Meas: W, PC	(6/2)
(1) Scratch coat mixture	
(2) Mixing instructions	

SUPERVISOR APPROVAL OF LESSON PLAN (PART II)

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ATC FORM APR 75 133 REPLACES ATC FORMS 337, MAR 73, AND 770, AUG 72, WHICH WILL BE USED.

PLAN OF INSTRUCTION/LESSON PLAN PART I (Continuation Sheet)

COURSE CONTENT

(3) Application procedures

(4) Curing procedures

c. Working individually, but as a member of a team and using given instructions, mix and apply a brown coat of plaster. Surface must be completely covered with no visible voids and must be ready for tiling. STS 9a(2), 9c(1), 9d, and 9f. Meas: W, PC (6/2)

(1) Brown coat mixtures

(2) Mixing instructions

(3) Application procedures

(4) Neet coat procedures

(5) Curing procedures

d. Working individually but as a member of a team, mix and apply stucco mortar to a prepared surface. Surface must be completely covered to a depth of 3/8 to 1/2 inch. STS 9a(2), 9c(1), 9d, 9f. Meas: W, PC (6/2)

(1) Mixing stucco and mortar

(2) Application procedures

(3) Finish coat

(4) Curing

e. Working as a member of a two-man team, inspect a plastered surface and identify all damaged areas. Make necessary repairs to bring the damaged areas back to their original condition. STS 9c(2), 9c(3), 9d, 9f. Meas: W, PC (3/0)

(1) Inspecting and checking plastered surfaces

(2) Repair procedures

SUPPORT MATERIALS AND GUIDANCE

Student Instructional Materials
SG 3ABR55233-IV-1, Applying Plaster and Stucco
WB 3ABR55233-IV-1-P1, Preparing for Plaster or Stucco
WB 3ABR55233-IV-1-P2, Mixing and Applying a Scratch Coat
WB 3ABR55233-IV-1-P3, Mixing and Applying a Brown Coat
WB 3ABR55233-IV-1-P4, Mixing and Applying Stucco
WB 3ABR55233-IV-1-P5, Maintaining and Repairing Plastered Surfaces
CDC 55233, Apprentice Mason

Audio Visual Aids
Transparencies, Applying Plaster and Stucco

Training Equipment
Hand Tools for Applying Plaster and Stucco (2)

Training Methods
Discussion (5 hrs)
Demonstration (4 hrs)
Performance (18 hrs)
Outside Assignment (8 hrs)

Multiple Instructor Requirements
Supervision (2)

Instructional Guidance
Discuss and demonstrate how to install lath, mix and apply plaster and stucco, and repair plastered surfaces. Divide the class into two-man groups and have them complete the workbooks. Make the following outside assignments: For day 31, have the students study SG 3ABR55233-IV-1. For day 32, have the students study paragraphs 21 and 22, chapter 7 in CDC 55233. For day 33, have the students study paragraph 23, chapter 7 in CDC 55233. For day 34, have the students study paragraph 24, chapter 7 in CDC 55233. The following references should be used when preparing the lesson: CDC 55233, Apprentice Mason, and AFP 88-27, Civil Engineer Handbook.

MIR: The class will be divided into six, two-man groups for the performance. Two instructors will be required to supervise these six groups.

PLAN OF INSTRUCTION/LESSON PLAN PART I

NAME OF INSTRUCTOR	COURSE TITLE
	Masonry Specialist

BLOCK NUMBER	BLOCK TITLE
IV	Plaster, Stucco, and Tile

1 COURSE CONTENT	2 DURATION (Hours)
2. Installing Wall and Floor Tile	29 (27/2) Last half of Day 35 thru Day 39 (3/2)
a. Using both hand and power tools and following given instructions, cut, drill, and shape tile to given specifications. Completed tile must comply with the given specifications. STS 14a(1), 14a(2), 14a(3), 14a(4), 14a(5). Meas: W, PC	
(1) Types of tile and their application	
(2) Types and method of application of bonding materials	
(3) Special tile working tools	
(4) Methods of cutting, drilling, and shaping tile	
b. Working as a member of a six-man team, and using directions, lay out an area for the application of tile. The completed area must be ready for the application of tile. STS 14b, 14c(1), 14c(2), 14c(3). Meas: W, PC	(6/0)
(1) Estimating the number of tile and amount of grout required	
(2) Leveling and smoothing the surface	
(3) Cleaning oil from the surface	

SUPERVISOR APPROVAL OF LESSON PLAN (PART II)

SIGNATURE	DATE	SIGNATURE	DATE

PLAN OF INSTRUCTION NO.	DATE	PAGE NO.
3ABR55233	12 November 1975	61

ATC FORM APR 73 133 REPLACES ATC FORMS 337, MAR 73, AND 770, AUG 72, WHICH WILL BE USED.

PLAN OF INSTRUCTION/LESSON PLAN PART I (Continuation Sheet)

COURSE CONTENT

c. Using given directions, install wall tile on a specified area. The tile must be installed in a straight line, adhere securely to the surface and present a pleasing appearance. STS 14b, 14c(1), 14c(2), and 14c(3). Meas: W, PC (6/0)

(1) Types of wall tile

(2) Types and application of bonding agents

(3) Fitting wall tile

(4) Setting wall tile

d. Using given direction, install floor tile on a specified surface. The tile must be installed in a straight line, adhere securely to the surface and present a pleasing appearance. STS 14b, 14c(1), 14c(2), 14c(3). Meas: W, PC (6/0)

(1) Types of floor tile

(2) Types and application of bonding agents

(3) Fitting floor tile

(4) Setting floor tile

e. Using prescribed materials and tools, fill tile joints to a specified depth and clean all excess grout from the polished surface. The joints must be filled to the specified depth, the excess grout removed and the finished work must present a pleasing appearance. STS 14d, 14e. Meas: W, PC (6/0)

(1) Mixtures

(2) Application procedures

(3) Wet cleaning

(4) Dry polishing

SUPPORT MATERIALS AND GUIDANCE

Student Instructional Materials
SG 3ABR55233-IV-2, Installing Wall and Floor Tile
WB 3ABR55233-IV-2-P1, Cut, Drill and Shape Tile
WB 3ABR55233-IV-2-P2, Lay Out an Area for Tile Application
WB 3ABR55233-IV-2-P3, Installing Wall Tile
WB 3ABR55233-IV-2-P4, Installing Floor Tile
WB 3ABR55233-IV-2-P5, Finishing and Cleaning Tile Surfaces
CDC 55233, Apprentice Mason

Audio Visual Aids
Transparencies, Installing Wall and Floor Tile

Training Equipment
Tile Cutter (3)
Tile Saw (12)
Hand Tools for Installing Wall and Floor Tile (2)

Training Methods
Discussion (4 hrs)
Demonstration (5 hrs)
Performance (18 hrs)
Outside Assignment (2 hrs)

Multiple Instructor Requirements
Supervision (2)

Instructor Guidance
Discuss and demonstrate how to lay out, cut, shape and install wall and floor tile. Divide the class into two groups and have them complete workbooks 3ABR55233-IV-2-P1 thru 2-P5. Make the following outside assignment: For day 35 have the students study SG 3ABR55233-IV-2. The following references should be used when preparing the lesson: CDC 55233, Apprentice Mason, AFP 88-27, Civil Engineer Handbook.

MIR: The class will be divided into two groups for the performance and each group will require one instructor.

	Course Material - UNCLASSIFIED 86 Hours TT BLOCK III - Laying Concrete Block Stone, and Brick	2 Hours RT 20 Hours CTT
4(1/5) 5 6	Cutting Masonry (6 hrs); Concrete Block Construction (18 hrs); Stone Construction (12 hrs); Brick Construction (24 hrs); Maintenance and Repair of Masonry Structures (4 hrs); Measurement Test and Test Critique (2 hrs). (Equipment Hazards and Personnel Safety Integrated with Above Subjects) 66 Hours C/L	

ATC FORM APR 73 449A PREVIOUS EDITION OBSOLETE.

COURSE CHART – TABLE II – TRAINING CONTENT 3ABR55233

NOTE: Include time spent on technical training (TT) (classroom/laboratory (C/L) and complementary technical training (CTT)) and related training (RT). Exclude time spent on individual assistance (remedial instruction). A single entry of time shown for a unit is C/L time. When a double entry is shown, the second entry is CTT time.

WK OF TNG \ HRS PER DAY 1 2 3 4 5 6 7 8		
	Course Material - UNCLASSIFIED 70 Hours TT BLOCK IV - Plaster, Stucco, and Tile	10 Hours CTT
7 8	Applying Plaster and Stucco (27 hrs); Installing Wall and Floor Tile (27 hrs); Communication Security (2 hrs); Measurement Test and Test Critique (2 hrs); Course Critique and Graduation (2 hrs). (Equipment Hazards and Personnel Safety Integrated with Above Subjects) 60 Hours C/L	10 Hours RT

3-20

23

PREPARE THE MAN

STUDY GUIDES 3ABR55233-III-1 thru -5

Department of Civil Engineering Training

Masonry Specialist

LAYING CONCRETE BLOCKS, STONE, AND BRICKS

August 1973

SHEPPARD AIR FORCE BASE

Designed For ATC Course Use

DO NOT USE ON THE JOB

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-III-3	Stone Construction	44
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This supersedes SGs 3ABR55233-III-1, 15 May 1972; -III-2, 22 March 1972; -III-3, 10 May 1972; -III-4, 10 May 1972; and -III-5, 13 March 1972.

Dept of Civil Engineering Tng
Sheppard AFB, Texas

SG 3ABR55233-III-1
9 August 1973

CUTTING MASONRY

OBJECTIVE

Upon completion of this unit of instruction you will be able to identify, maintain and use masonry tools and be able to cut and shape various types of masonry materials.

INTRODUCTION

One of man's earliest developments was his use of masonry. As early man started developing, he discovered that he could use rocks and stones for tools, weapons, and shelter. The first shelter was a pile of rocks to keep wild animals and enemies out of his cave. Later he learned that mud packed between the rocks would keep out the wind and cold. Our modern skyscrapers are a result of this humble beginning.

TOOLS

The masonry field like all crafts, has several tools that are pertinent to this specialty alone. As a masonry specialist, you must know how to use and care for these tools.

Power Mortar Mixer

The power mortar mixer (see figure 1) is designed to blend and mix various types of masonry mortar. These mixers are available in capacities of 3 to 8 cubic yards. If you need less than 1 cubic yard of mortar it may be faster to mix it by hand. It may take longer to clean up the mixer after use than to mix the mortar by hand.

Power mixers are usually driven by an electric motor or a gasoline engine. The electric type must have a power source, while the gasoline engine type can be operated at remote construction sites.

Operate these mixers according to the manufacturer's instructions, paying particular attention to the safety precautions.

Masonry Saw

The masonry saw (figure 2) is used to cut block, stone, or brick to an exact size. It is best to order masonry materials in the size required. Masonry saw blades are expensive and it is time-consuming to have to cut material to size. However, you will have to use the masonry saw for special applications or when the correct size material is not available.

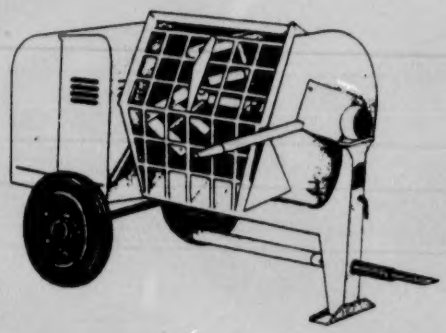


Figure 1. Power Mortar Mixer

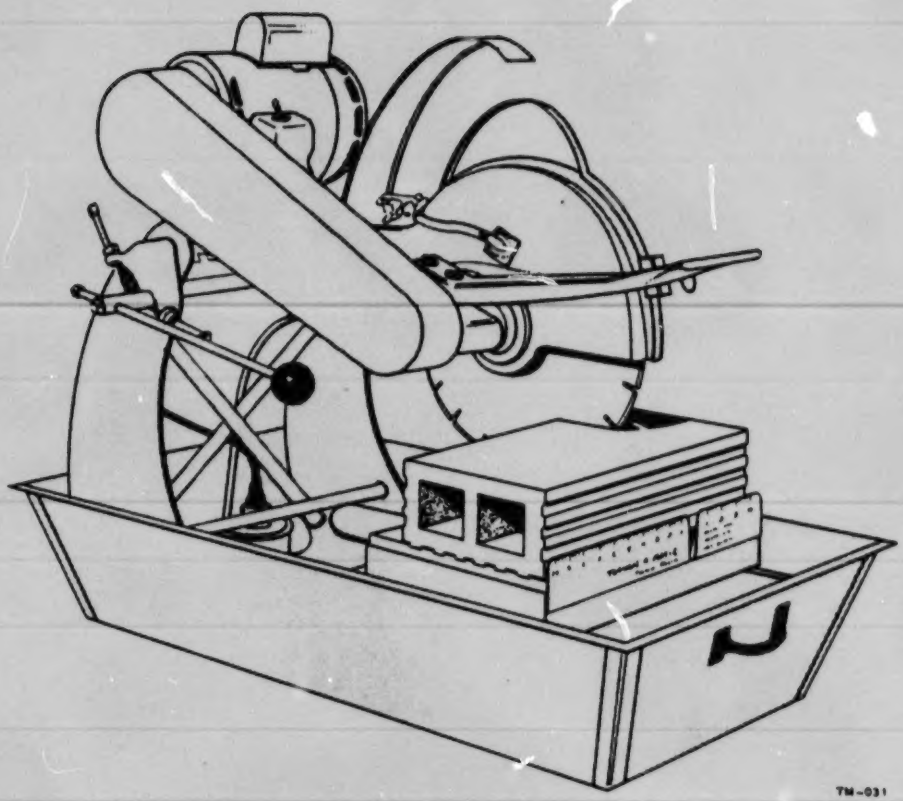


Figure 2. Masonry Saw

Mortar Hoe

This tool is necessary when mixing mortar of any kind by hand. The two holes in the blade allow mortar ingredients to pour through them and increase the speed of mixing. Figure 3 shows a two-hole mortar hoe.

Figure 3. Mortar Hoe

Shovel

Square-pointed, long-handled shovels are very useful when it comes to mixing mortars or plasters and placing them in the hod. Short D-handled shovels are also used as a matter of choice. The long-handled, round-pointed shovel also is very useful as a utility shovel. Figure 4 shows a long-handled, square-point shovel.

Figure 4. Square-pointed Shovel

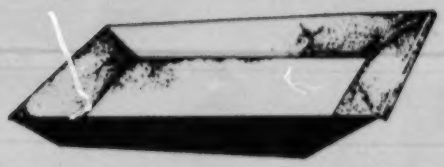


Figure 5. Mixing Box

Brick Hod

A brick hod (figure 6) is a "V" shaped container attached to a long handle. It is used for stacking scaffolds and carrying brick up ladders. Moving brick with a brick hod is a hard, time-consuming job. However, sometimes it is the only way to get the job done.

Brick Tongs

A set of brick tongs (figure 7) is the best tool available to manually move bricks. An experienced man can move several bricks at a time without touching any of them with his hand.

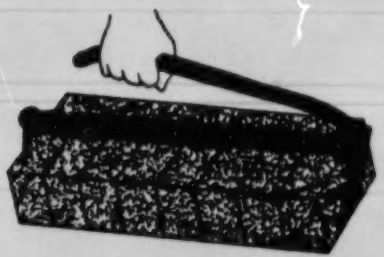


Figure 7. Brick Tongs

Mixing Box

A mixing box (figure 5) is used to mix small amounts of mortar. You will use a mixing box very often for repair and small construction jobs. After you use the mixing box, it must be cleaned thoroughly before the mortar has time to set.

Figure 6. Brick Hod

Brick Trowel

Good brick trowels are forged of high-carbon steel, and are taper-ground and polished to give them a high degree of flexibility and smothness. Brick trowels are manufactured in several patterns, shapes and sizes. Several patterns and heel widths are illustrated in figure 8.

Pointing Trowel

A small size trowel, known as a pointing trowel is illustrated in figure 9.

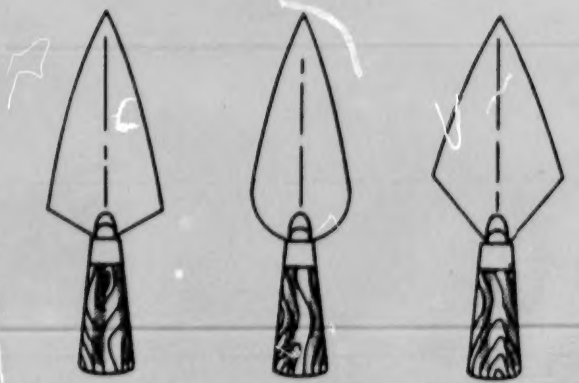


Figure 8. Brick Trowels

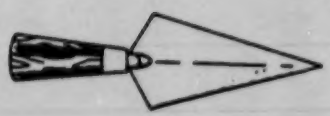


Figure 9. Pointing Trowel

This small trowel is used to point cross and head joints between masonry units. This trowel is often used to fill defective joints and for repointing and repair work.

Caulking Trowel

Caulking trowels or slickers have narrow square-pointed steel blades of various widths. A double-bladed caulking trowel, since it is not in reality a trowel, is often referred to as a slicker. The tools are used for tooling masonry joints that are flat and flush. Figure 10 shows both a single-bladed and a double-bladed caulking trowel.

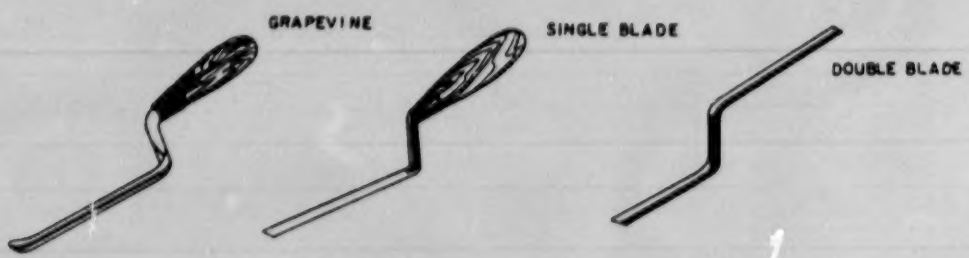


Figure 10. Caulking Trowels

Brick Jointers (Sometimes Called Strikers or Striking Irons)

There are several types, shapes, and sizes of jointers. The jointer is used to tool mortar joints to some shape, other than flat. The joints take on shapes such as V, convex, concave, and others, depending upon the shape of the blade. The double-bladed V and convex tools are called jointers. However, to differentiate between them and single-bladed jointers and concave jointers, the single-bladed jointers are often referred to as sled runners and the concave tools as beaders.

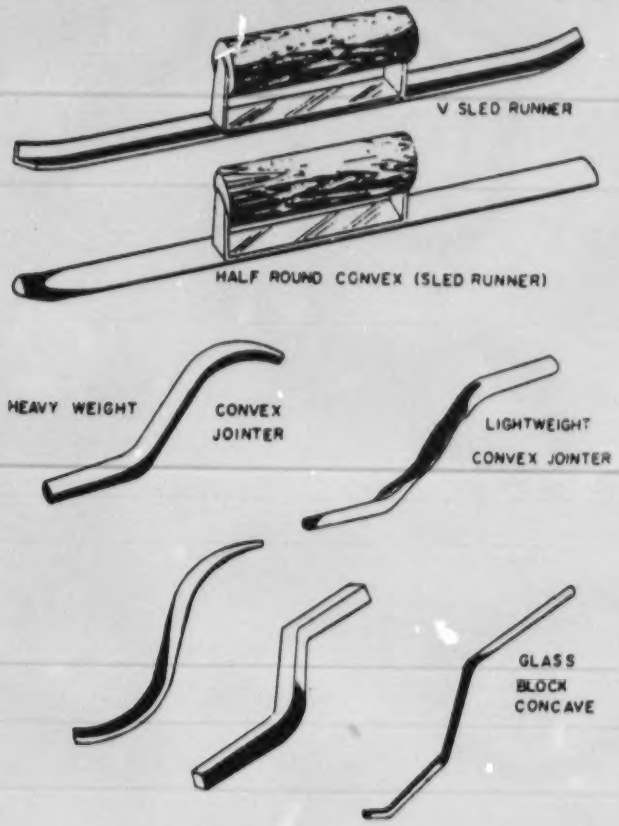


Figure 11. Brick Jointers

Figure 12. Lightweight Beader

Beader

The beader is the opposite of the convex jointer. A lightweight beading tool is shown in figure 12. Like other lightweight jointers, the lightweight beader is usually made 1/8-inch smaller at one end than at the other so that two different-sized beads may be made with one tool.

Brick Hammer

A brick hammer, similar to but unlike a scutch, is used for both pounding and cutting. It has both a cutting blade and a square peen for pounding or breaking and splitting brick or block. A brick hammer is shown in figure 13.

Figure 13. Brick Hammer

Figure 14. Bevel Edge Set

Bevel Edge Set

A bevel edge brick set is used to cut and shape brick. Sometimes a scoring saw is used to cut a groove in hard brick, then a brick set of this type and a brick hammer are used to complete the job of cutting. Brick that is soft may not need to be scored first. Figure 14 shows a bevel edge brick set.

Flat chisels are used for butting sheet metal. Cape chisels are used to cut grooves, slots, and keyways. Round nose chisels cut round grooves and diamond point chisels are used to cut V-shaped grooves.

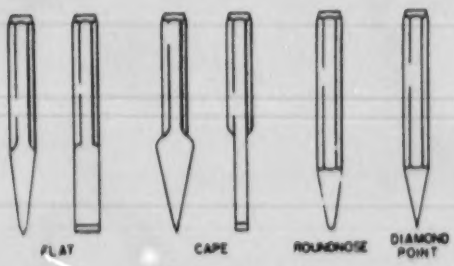


Figure 15. Flat Chisels

Figure 16. Joint Rake

Joint Rake

A joint rake (figure 16) consists of an aluminum frame on wheels. A common nail head end down, is used as a raker blade. The nail is inserted in the tool and locked in position by means of a thumbscrew. The nail rakes out mortar as the joint rake is pushed and pulled over the joint with the wheels running on each side of the joint.

Wire Brush

Many different stypes of wire brushes are used by masons for cleaning masonry and concrete surfaces. The type selected depends upon the cleaning job to be done, and also upon which one the mason likes to use. Figure 17 shows several types of wire brushes, one of which has a scraper attached to the front end.

Figure 17. Wire Brushes

Figure 18. Self-Chalking Line Box and Plumb Bob

Self-Chalking Line Box and Plumb Bob

A self-chalking line box and plumb bob is illustrated in figure 18. This unit can be used to lay a chalk line or as a plumb bob.

Spacing Rule

A mason can use a spacing rule (Fig. 19) to determine how much mortar it will take to construct a wall using standard size brick and uniform mortar joints.

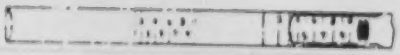


Figure 19. Spacing Rule

Modular Rule

This is an aluminum rule similar to the one above, but calibrated for Engineers, Economy, and Modular Roman, as well as for standard brick. Figure 20 shows an aluminum modular rule.

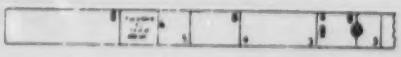


Figure 20. Modular Rule

Spring Joint Zig-Zag Rule

The mason uses this type of rule more than any other. He carries it with him constantly, when at work, and makes most of his measurements with it. Those rules which are fitted with a slide in one end may be used for inside measurements as well as outside measurements. A zig-zag rule, with the slide extended, is shown in figure 21.

Figure 21. Zig-Zag Rule

Figure 22. Measuring Tape

Measuring Tape

Common sizes of steel measuring tapes are 25, 50, 75, and 100 feet long. The tapes are useful in making long measurements when establishing building lines. The steel tape is shown in Fig. 22.

Level

This tool is used to check surfaces to determine if they are perfectly vertical or horizontal. They are also used during construction to aid in positioning units so that they will be plumb (vertical) or level (horizontal). Some levels may be adjusted so that specific angles may be obtained.

Different types of spirit levels or plumb rules are used by brick masons to plumb and level their work. Most of the levels are made from mahogany with a full angle brass binding. Some levels have depressions in the body of the level to facilitate holding, and some have hand holes. Three types of levels are shown in figure 23.

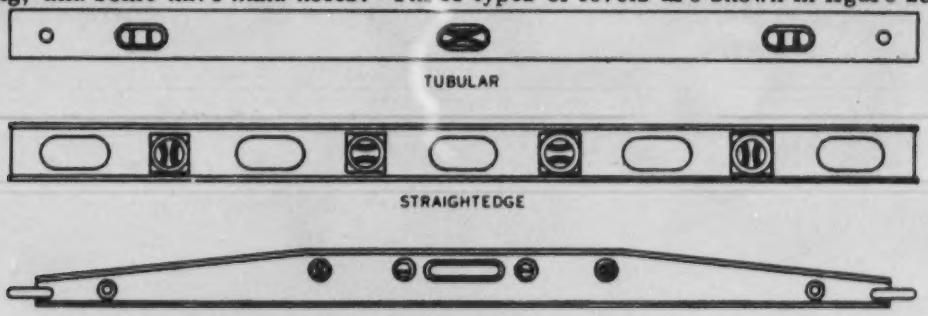


Figure 23. Levels

Vials installed near the ends of levels give plumb readings. Vials installed at the center of the level give level readings. Double vials are installed in most brick levels so that readings may be obtained regardless of which edge is placed against the material. Vials are ordinarily made of glass and filled with a spirit of some type that freezes only at very low temperatures. A type of vial consisting of a thick plastic disc which has been drilled laterally to hold the spirit is being used.

Glass vials in levels should be protected by glass or plastic windows cemented in position over the vials on each side of the level. Some levels, however, are not fitted with glass windows and the glass vials often get broken. The full angle type of binding, and the plastic disc type of vial are shown in figure 24.

Story Pole

Mortar joint thickness is specified by the architect or structural engineer in the building plans. The brick mason lays out the height of each course (including the bed joint) on a strip of wood called a story pole or rod, so that the height of each course may be checked against the rule as the brickwork progresses. Figure 25 illustrates how a story pole is used.

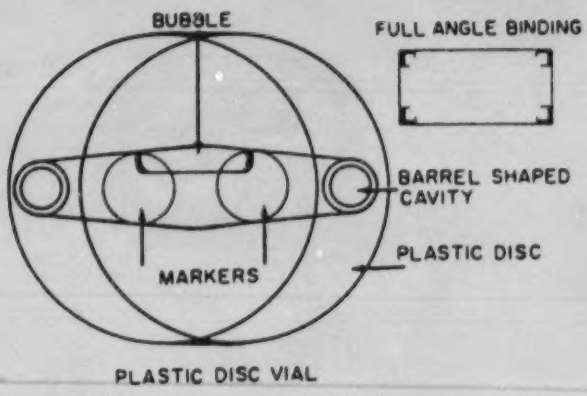


Figure 24. Full Angle Binding and Plastic Vial

Line

Brick masons use line to lay out the limits of constructions. The lines are white or colored, and are made from cotton and nylon. Cotton line often comes in hanks or skeins. Nylon line is usually wound on tubes or on winders. Nylon lines commonly used are 40-pound test, while cotton lines are 100-pound test.

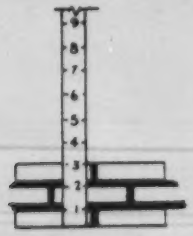


Figure 25. Story Pole

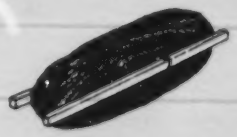


Figure 26. Line and Line Winder

Line Winder

Some line winders are made of cardboard. Others are constructed of thin plywood and have a line cutter installed on the winder. Winding line on good wooden winders is the best method of keeping a sufficient amount of line available for immediate use, and keeping it in good condition. Figure 26 shows line wound on a line winder.

Line Pin

Line pins are placed between masonry units to hold the brickmason's line. The pins must be very strong, so they are made of tempered tool steel. A pair of bricklayer's line pins are shown in figure 27.

Figure 27. Line Pins

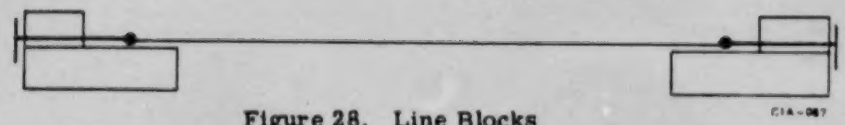


Figure 28. Line Blocks

Line Block

Line blocks are often used instead of line pins to hold the bricklayer's line. These line holders, which are placed over a corner or around a corner on the other wall, eliminate snarls and knots in lines and the need for sticking pins in the mortar. Two types of line blocks are shown in figures 28 and 29.

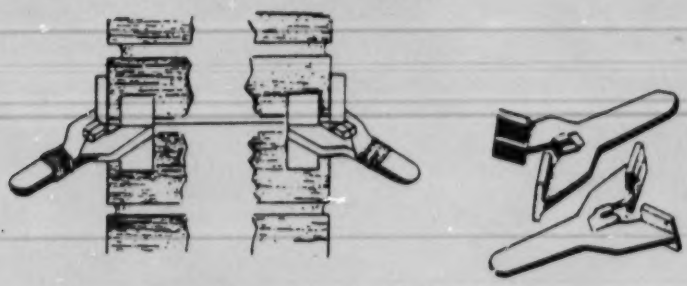


Figure 29. Line Blocks

Line Twig

Line twigs are used between line pins or corner blocks to keep the line from sagging, and to keep it the correct distance away from the block course. After a twig has been clipped over the line, a masonry unit is placed upon the twig to hold it in position on the wall. A pair of line twigs are shown in Fig. 30.

Figure 30. Line Twigs

MATERIALS

Mortar

Mortar is defined as "a combination of cement, sand, and water mixed in the correct proportions to produce a mix of workable consistency."

The mortar commonly used for laying masonry units is made with masonry cement. If this cement is not available, you use normal portland cement and hydrated lime mixed in the proper proportions. The recommended amount of materials proportioned by volume for mortar mixes is shown in figure 31. Mortar made with these mixtures will produce a strong bond between masonry units. Good mortar is necessary for good workmanship. Since mortar must bond masonry units into a strong, well-knit, water-tight wall, it must contain a number of desirable properties. Let's examine some of them.

2R- 74-327

WORKABILITY. Mortar is said to be workable when it spreads easily and remains firmly in the mortar joints. A workable mortar will always adhere to masonry units. There is no need to add agents (lime, etc), to mortar made with masonry cement, because the cement itself produces the desired workability. The workability also depends partly on good mortar sand.

One sack of masonry cement = one cubic foot - approximately 70 lbs.

Type of Service	Cement	Mortar sand in damp, loose condition	Hydrated lime
For ordinary service	1 - masonry cement or 1 - portland cement	2 to 3 4 to 6	1 to 1 1/4
Subject to heavy loads, violent winds, and severe frost action	1 - masonry cement plus 1 - portland cement or 1 - portland cement	4 to 6 2 to 3	0 to 1/4

Figure 31. Recommended Mortar Mixes

One sack of portland cement = one cubic foot - approximately 94 lbs.

One sack of lime = one cubic foot - approximately 50 lbs.

WATER RETENTION. Mortar made with masonry cement also has good water retention which prevents rapid loss of moisture when used with dry masonry units. Good water retention will permit the mortar to remain soft and plastic long enough to aline and level the masonry units. To avoid the rapid loss of water from suction, some masonry units must be moistened before they are used.

Never wet the concrete block to control the loss of moisture. Concrete block will not absorb water from the mortar like other types of masonry units. Masonry units, such as clay brick, tile, etc, must be wetted before they are used. The use of entrained air will add to the workability and water retention of the mortar.

AGGREGATE. To make a good mortar, it is necessary to use sand that is free of dirt, vegetable matter, and salts. If the sand is uniformly graded and proportionately mixed, an even better mortar can be produced. In a well-balanced aggregate mixture, a certain percentage of the sand must pass through a sieve of a given size. The sieve numbers and the percentages of sand that should pass through the sieves are shown in figure 32. There are several types of mortar sand, each having its own characteristics; so, it would be difficult to specify the exact amount to use in preparing mortar. There should be enough particles of fine sand so that, when coated with cement paste, they

fill the major voids between the coarser sand particles. An excessive number of fine particles requires more cement paste than a well-graded mixture.

Sieve Number	Percentage of Sand Passing Through Sieve
4	100
8	97
16	84
30	50
50	27
100	6

Figure 32. Graded Mortar Sand Mixes

WATER. The water used for making mortar should be as pure as drinking water. It should be free from chemicals, such as salts and alkalies. Large amounts of these chemicals or organic matter will affect hydration and the quality of mortar. To have the best possible mortar, the materials must be properly wetted and thoroughly mixed.

MIXING. Machine mixing should always be used except on jobs where the requirement for mortar is small. After the proper ingredients have been proportioned and placed in the mortar box or mixer, the quality of mortar will depend on the mixing time. The quality of hand-mixed mortar can be improved by mixing it for a long period of time. The same tools are used to mix mortar and concrete.

Mortar that has stiffened on the mortar board should be retempered to regain its workability by remixing and adding more water. After mixing, the mortar should be used within 2 to 2 1/2 hours if the temperature is 78°F, or higher. If the temperature is below 78°F, the mortar should be used within 3 1/2 hours. Any mortar not used within the time indicated should be disposed of.

Concrete Blocks

Concrete blocks are designed for use in all types of masonry construction. Some of the uses are:

* Exterior load-bearing walls
* Interior load-bearing walls
* Fire and curtain walls
* Partition and panel walls
* Backing for brick, stone, and facings
* Fireproofing over structural members
* Fire-safe walls around stairwells, elevators, and other enclosures

- Piers and columns
- Retaining walls
- Chimneys

Types of Concrete Masonry Blocks

HEAVY AND LIGHTWEIGHT BLOCKS. The different types of blocks are made with heavyweight or lightweight aggregates and are referred to as heavyweight and lightweight blocks. A hollow load-bearing concrete block of 8" x 8" x 16" nominal size weighs from 40 to 50 pounds when made with heavyweight aggregates, such as sand, gravel, crushed stone, or air-cooled slag.

Concrete blocks made with lightweight aggregate weighs from 25 to 35 pounds and are made with coal cinders, expanded shale, clay, slag, or natural lightweight materials such as volcanic cinders and pumice. Heavyweight and lightweight blocks are used for all types of masonry construction. The choice depends on availability and the requirements of the structure under consideration.

SIZES AND SHAPES. Concrete building blocks are sized and shaped to fit different construction needs, as shown in figure 33. Unit sizes usually refer to their nominal dimensions. A unit measuring 7 5/8-inches high, 7 5/8-inches wide, and 15 5/8-inches long is referred to as an 8- x 8- x 16-inch unit. When it is laid in a wall with 3/8-inch mortar joints, the unit will occupy a space exactly 16 inches long and 8 inches high.

Reinforcing Materials

Because the strength of concrete block masonry in tension is low, as compared with its compression strength, reinforcing steel is used when tensile stresses are to be resisted. In this respect, block masonry and concrete construction are identical. The reinforcing steel is placed in the horizontal or vertical mortar joints. Reinforced block masonry may be used for beams, columns, walls, and footings in the same manner as reinforced concrete. Structures built of reinforced block masonry have successfully resisted the effects of earthquakes intense enough to severely damage unreinforced block structures.

There are several types and shapes of reinforcing materials used in concrete block construction. A few of the common types of reinforcing materials are: 1/4" steel rods; 3/8" and 1/2" deformed steel; wire mesh; and horizontal reinforcement made of two deformed #9 or heavier longitudinal wires.

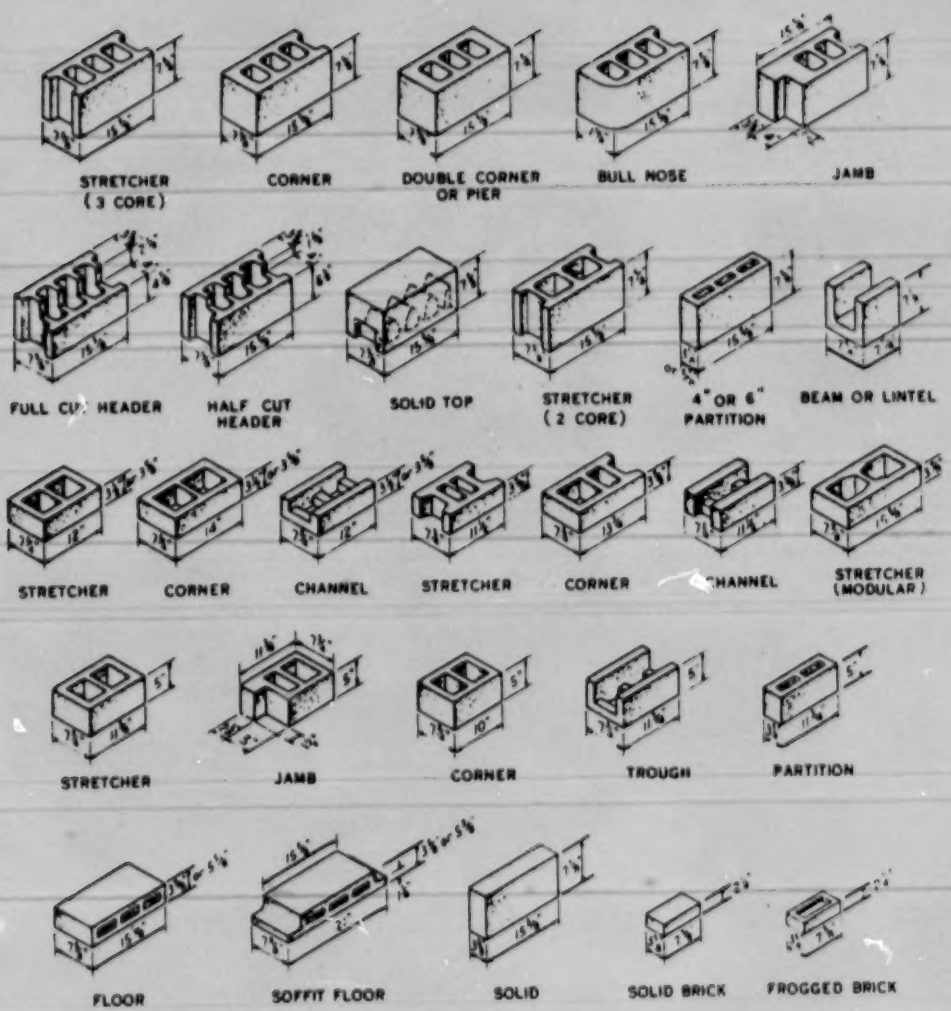


Figure 33. Shapes and Sizes of Concrete Blocks

STRUCTURAL CLAY TILE

Clay tile units are designed and made for use in various types of masonry construction. Some of its uses are for:

* Backing for brick, stone and facings
* Exterior and interior load-bearing walls
* Fire and curtain walls
* Fire-safe walls around stairwells, elevators and other enclosures
* Farm buildings such as silos and dairy barns
* In walls where low heat transfer is required
* Tile and concrete floors at grade level
* Ceilings

Types of Clay Tile

POROUS TERRA COTTA. Porous terra cotta tile is made of brick clay mixed with some organic material such as straw, sawdust, or other similar material. The organic material is burned away and leaves the tile porous. The tile holds plaster well and can be nailed. Good porous terra cotta tile produces a ringing sound when tapped with a hammer. The shell (outer wall) of porous terra cotta hollow tile is normally about 3/4 to 1 inch thick, and the web (partition) about 1/2 to 3/4 inch thick.

HARD TILE. Hard tile is made of fire clay mixed with pottery clay or one of the tougher better grades of brick clay. The tile is formed under heavy pressure to make it very dense.

VERY HARD BURNED TILE. This tile is used where resistance to moisture is a factor. It is a vitreous tile that will absorb approximately 8 percent of its weight when covered with water for 24 hours. This tile is harder than that required for the ordinary tile wall which is to be stuccoed or veneered with other masonry units.

STANDARD BURNED TILE. This tile is ordinarily used as a base for stucco and as a backing for veneering masonry.

MEDIUM BURNED TILE. Medium burned tile will absorb more than 12 percent of its weight in water in 24 hours. It is used in walls where moisture and heavy loads are not a problem.

DOUBLE SHELL TILE. Double shell tile has two sets of walls, one set inside of the other. Each wall is separated from the other.

Nominal and Actual Sizes

Some structural hollow clay tile units are occasionally referred to by dimensions which are not their actual measurements. For example, a tile which by actual measurement is 3 5/8-inches thick, 7 3/4-inches high, and 12-inches long may be referred to by some as being a 4-inch by 8-inch by 12-inch tile. This is its nominal size. The fractions are cleared to the nearest whole number to obtain the nominal dimensions. This is not good practice, however, and should be avoided whenever possible. The practice tends to cause errors.

The use of nominal dimensions probably stems from laying common sized tile units, such as the one which is 3-3/4 inches by 7-3/4 inches by 12 inches, with 1/4-inch mortar joints. The size of the unit plus the mortar joint is 4 inches by 8 inches by 12 inches.

When a different thickness of mortar joint is used with the unit, or when a slightly different sized unit is used, the result is different. Mistakes in planning, designing, and laying tile units can result when nominal dimensions are used.

Shapes of Tile and Their Uses

LOAD-BEARING UNITS. Load-bearing hollow tile units may appear to be the same shape as nonload-bearing or partition units; however, the shells and webs are thicker. Figure 34 shows two shapes of load-bearing tile.

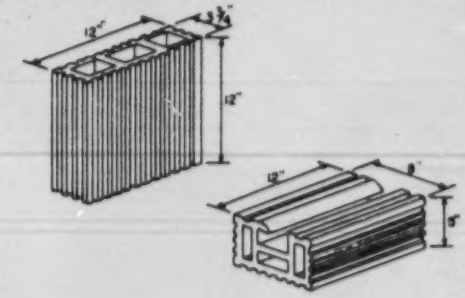


Figure 34. Load-Bearing Clay Tile Units

PARTITION UNITS. Partition structural hollow tile units, having thinner webs and shells than load-bearing units, are similar in shape. Figure 35 shows two shapes of partition or nonload-bearing hollow tile units.

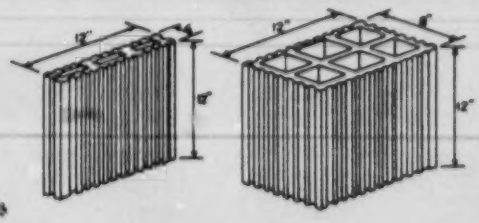


Figure 35. Partition Clay Tile Units

BACKUP UNITS. Backup units are load-bearing structural hollow tiles which may be used as backing for brick or other masonry materials. It is also used to construct solid and cavity (hollow) tile walls, and to build disposal drain lines. Figure 36 shows a typical backup tile unit.

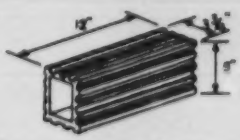


Figure 36. A Backup Tile Unit

FURRING UNITS. Furring units are placed over structural members as fireproofing. They are used to cover interior surfaces of concrete, brick, and other masonry surfaces to provide a keyed surface for plaster. Figure 37 shows one shape of furring unit.

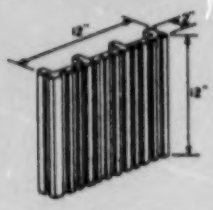


Figure 37. A Furring Unit

Figure 38. A Corner Closure

CORNER CLOSURES. Corner closures are used to make tile wall corners, and they may be placed around openings to form jambs. They are particularly useful as corner units when constructing load-bearing walls. Figure 38 shows a corner closure.

UTILITY UNITS. Utility units are tiles which may be used in walls as whole tiles or used as corner closures. Each tile is formed so that it can be easily broken into closures of different lengths. Figure 39 shows a smooth utility unit.

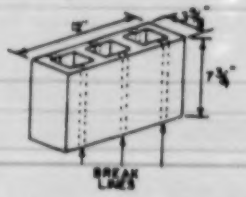


Figure 39. A Utility Tile Unit

JAMB UNITS. Jamb units of structural clay tile are specially shaped to accommodate the installation of window and door jambs. Some units are made for metal frames or sash, while others are made for wooden jambs. The tiles are laid in the wall around the window and door openings to form the masonry jambs and headers of the openings. Figure 40 shows two typical jamb units. One is for a metal, and one is for wooden jambs.

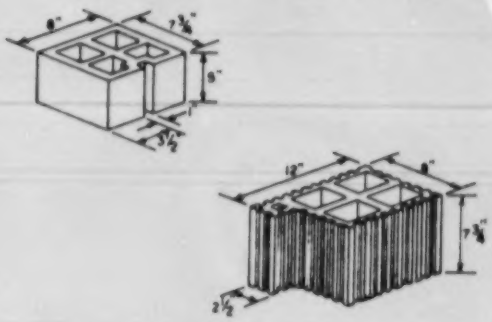


Figure 40. Typical Jamb Units

HALF-JAMB UNITS. Half-jamb units, with two cells, are only one-half as long as jamb units. The units are used around openings for holding the steel frames for windows.

HEADER UNITS. Header units are primarily shaped for headers and sills in walls having a brick facing and tile backing. Figure 41 shows a typical header unit.

T UNITS. T-shaped tile units are used in solid tile walls or tile walls faced with brick. The unit is commonly laid in the wall so that the larger cells are in the backing up tier of masonry. Figure 42 shows a typical hollow clay tile T unit.

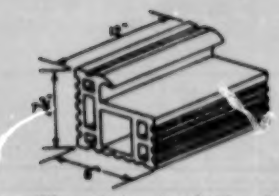


Figure 41. A typical Header Unit

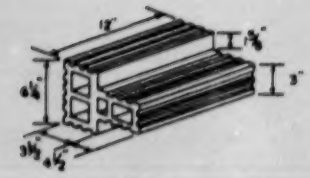


Figure 42. A Typical T Unit

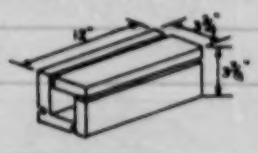


Figure 43. Cluster Units

CLUSTER UNITS. Cluster units are used in conjunction with T units to close the starting point of the wall. Closures of appropriate shape and size may also be used along with cluster units. Figure 43 shows a typical smooth cluster unit.

JUMBO UNITS. Jumbo units and closures of suitable size are used for fine tile construction. It is used in all tile wall construction where good appearance must be considered. Figure 44 shows a jumbo unit which looks like a long brick, and which is sometimes called a jumbo brick.

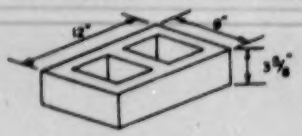


Figure 44. A Jumbo Tile Unit

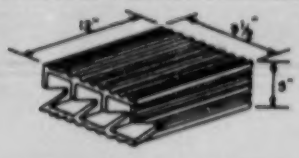


Figure 45. A Flat Arch Floor Unit

ARCH UNITS. Several shapes of flat arch floors. Figure 45 shows a special unit of clay tile which is shaped to fit over the flanges of I beams.

SHOES. Shoes are structural clay tile units specially shaped to fit over the flanges of I beams. They are typical fireproofing tile units, and one such unit is illustrated in figure 46.

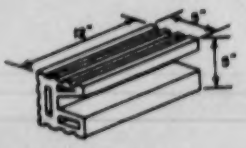


Figure 46. A Typical Tile Shoe Unit

ROOFING TILES. Roofing tiles are manufactured in various shapes and sizes. The general contour of some roof tiles is flat. Other roof tiles are shaped to produce a corrugated effect. The tiles themselves are of solid construction and contain no cells or cores. They are shaped to overlap each other, and are usually wired or nailed to roof members by the carpenter.

Surface Finishes

Glazed tile units with smooth surfaces are used on the interiors of hospitals, industrial plants, dairies, homes, and other places where there is the problem of maintaining cleanliness and good appearance. Glazed tile units, called face tile, which have smooth surfaces are used on the exterior of buildings. Others of these tiles are made having surfaces to imitate stone.

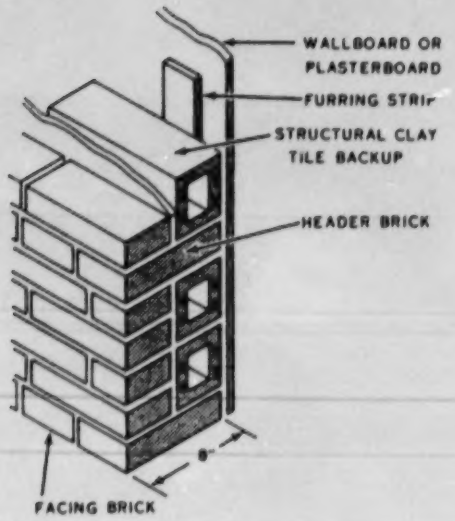


Figure 47. Using Structural Tile for Backup

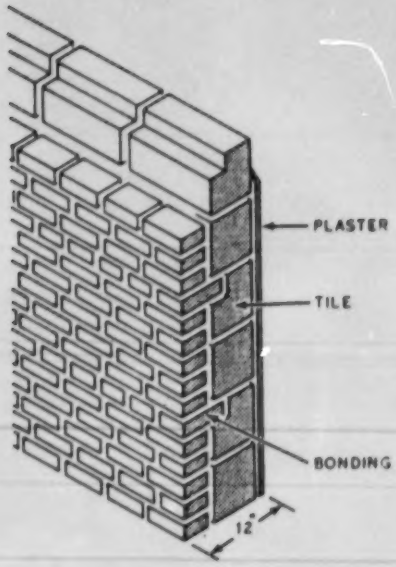


Figure 48. How Structural Tile are Used

STONE MASONRY

Much of the earth's surface consists of stone formations from which many varieties of building stone are quarried. Other stones lie on top of the ground and are picked up for building purposes. The stones are found in varying degrees of hardness, depending mainly upon their chemical composition. Some building stones are very hard, and some are very soft.

Types of Stone Used in Construction

When classified according to the principal mineral component in its formation, building stone falls into three general classes. The classes are siliceous stone, calcareous stone, and argillaceous stone.

SILICEOUS STONE. Siliceous stones are those which contain a considerable amount of silica. Some stones in this class are commonly known as granite, gneiss, and traprock. Granite is a hard, durable stone containing quartz (hexagonal silica crystals) which has been formed in the earth by heat. It is of varied colors which are primarily reds, grays, or whitish. Gneiss, similar to granite, is found in laminated formation created by heat or accumulated sediment. Traprock is also found in sheet-like masses in stairstep formations. It is a hard fine-grained stone containing silica which has been formed by being fused together with other minerals, by heat, to form a durable rock.

CALCAREOUS STONE. Calcareous stones are those commonly known as limestones and marbles. Lime is the main component in these stones.

ARGILLACEOUS STONE. Argillaceous stones are those which are clay-like or consist of clay. Common stones of this class are clay or shale, slate, and porphyry. The latter is a dark red to purple rock that has been formed by heat within the earth.

LIMESTONE. Limestones are composed chiefly of carbonate of lime or varying proportions of carbonate of lime and carbonate of magnesia. The stones may be close-grained, medium-grained, or coarse-grained, depending upon whether clay, sand, and shell are included in the formation. Generally speaking, the stones are deteriorated by the action of fire and abundant amounts of acids in the air.

SANDSTONE. Sandstones are composed of grains of sand cemented together by silica, alumina, carbonate of lime, in an oxide of iron. The stones may be of varied colors of cream, blue, pink, red, grey, and brown. The best sandstones are those which are close-grained, and which contain siliceous cementing material. Sandstones containing lime are susceptible to acids in the air, and to fire action. Those containing an oxide of iron may stain.

GRANITES. Granites are composed chiefly of quartz, felspar, and mica. Those containing a greater proportion of quartz are the strongest and most durable of building stones. For these reasons, granite stone is used for foundations, bases, facings, columns, paving, and other like structures.

SLATES. Slates are composed chiefly of clay and sand which have been combined into a close-grained stone by earthly actions of pressure, heat, and water. It is in laminated form and can be split into sheets and cut to size for roofing facings, black-boards, and other forms of building stone.

Selecting Stone

The main consideration of the architect or structural engineer in selecting building stone is the climate. Stone found to be very durable under mild climatic conditions may decay quickly when subjected to salty air and driving winds. Acids in the air of industrial cities has a decomposing effect upon calcareous stone such as the limestones and sand-stones containing substantial amounts of lime and magnesia. Siliceous stone such as slate resists adverse weather conditions and acids in the air. It is fine-grained stone that is hard and tough. It is also nonabsorbent, and therefore, is used primarily for roofing.

STRENGTH. Building stone which supports heavy loads must be strong. The weight of the masonry and the loads transmitted to it by roofs, floors, and other structural parts of a building result in great pressure on the stones. The pressure is especially great on the lower courses of stone. The lower the compressive strength of building stone is, the thicker the wall has to be to support a given load.

DURABILITY. The durability of stone depends greatly upon its physical structure and chemical composition. Durability of stone varies greatly according to the nature and magnitude of atmospheric conditions to which it is subjected. Consequently, a building stone that is durable under certain atmospheric conditions may not be durable under different weather conditions.

COST. The lowest priced stone which will meet building requirements should be used, unless cost is not a problem.

APPEARANCE. Appearance is a requirement of building stone, because stone is historically representative of beauty in building construction. Stone that contains much iron should be avoided, because oxidation of the iron by atmospheric conditions may cause the building to be marred by rust stains.

Type of Finish

Building stones are those which are used in their natural state or as they come from the quarry. Rough stones are used extensively in constructing the walls of small buildings and in fences. In many localities the stones have been picked up off the land and used in the construction of the buildings and other structures there. Rough stone provides for the simple bond and pattern of rustic stone construction, which is commonly used.

Classification of Stone Masonry

Stone masonry may be classified in several ways. Classification may be made on the basis of kind of stone, with regard to finish, or from the standpoint of bonding. One way of classifying stone, however, which is often used, is with regard to the degree with which the stones are squared or dressed to approach their general shape. Stones which are not worked are called unsquared stones or rubble. Stones which are partially worked are called roughly squared stones. Stones which are worked until they are square and fairly smooth are called squared stones. Stones which are completely and accurately squared and smoothed are called cut stones. Rubble masonry consists of unsquared rough stones from the quarry, beach, and fields, or cobblestones from the earth. The irregularities of the stones are compensated for by filling the space between the stones with mortar as they are set. Rough stones from the quarry are preferable because they come nearer being rectangular than the others, and form a better bond.

BRICK MASONRY

Definition of Brick

The ordinary brick is a unit of clay approximately 2 1/4 by 3 3/4 by 8 inches in size that has been air-dried or burned. A portion of a brick is commonly called a bat or brick bat. More specifically one-half of a brick is known as a 4 1/2-inch bat. Any length of brick that is shorter than full length, but longer than 4 1/2-inch bat is known as a three-quarter bat.

Kiln run brick includes bricks hard enough for exteriors of structures. They are known by names such as hard, common building, paving, hard building, outside, hard red, strictly hard, select hard, rough hard, hard washed, kiln run hard, and common hard brick.

Soft or salmon brick includes bricks not hard enough for exterior walls of structures. They are known by such names as soft salmon, backing-up, pale light, chimney, filling-in, inside wall, and foundry brick.

Sizes of Brick

There are two standard sizes recommended for ordinary brick. Common brick and rough-faced should be 2 1/4 by 3 3/4 by 8 inches. That is, a brick this size is

2 1/4 inches-high or deep, 3 3/4-inches wide, and 8-inches long. Smooth-faced brick or pressed brick should be 2 1/4 by 3 7/8 by 8 inches. The size of the brick will vary slightly from these sizes because of shrinkage during the burning process. Aside from the two sizes mentioned above, brick are, however, made in other sizes. Firebrick is ordinarly made 2 1/4 by 4 1/2 by 9 inches in size.

Weight of Brick

The weight of brick will vary according to the size, the amount of burning, and the types and processing of materials used in their manufacture. The approximate weight of a common brick is 4 1/2 pounds.

Brick are available in forms other than standard dimensions. They are manufactured in special forms for special applications. Some of the specialized forms and their nomenclature are shown in figure 49.

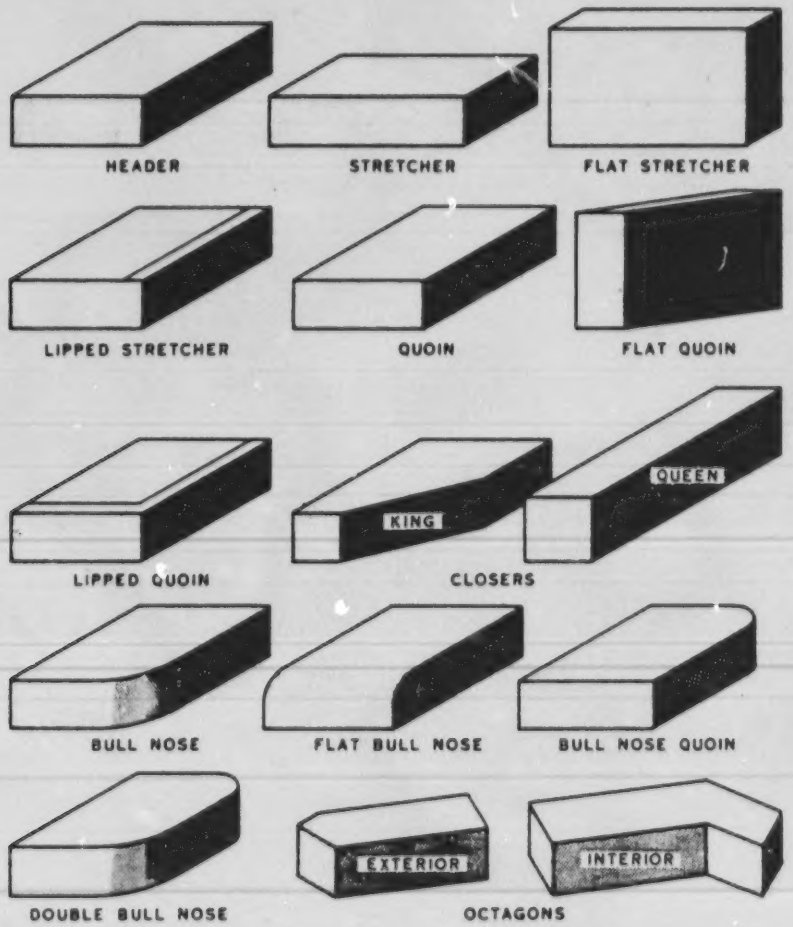


Figure 49. Various Forms of Brick

Kinds and Use

COMMON. Common bricks are made of the most common types of clay, and are burned in kilns in the usual manner. They do not have special markings, scoring, nor do they have special colors or surface textures. Grades of common brick will vary in different localties. In some sections of the country the bricks are marketed without grading as to hardness and strength. In other sections the bricks are graded and sold as front and back bricks. The front bricks are those which have been burned to a higher degree of hardness. In still other sections common bricks are graded as hard and kiln-run bricks. In nearly all localities, the overburned brick are called clinkers. These bricks are hard and durable.

In some cases, manufacturers will classify bricks according to their position in the kiln. Such terms as arch, clinker, rough-hard, red, well-burned, straight-hard, stretcher, soft, and salmon are applied. Arch, clinker, and rough-hard bricks are hard and durable, and may be slightly irregular in shape. Red, well-burned, and straight-hard bricks are well burned, but not overburned; and the most select of these bricks in size, hardness, and durability are called stretchers. Soft and salmon brick, farthest from the fire, are underburned and are not as strong and durable as the other bricks. (However, clay from certain localities will produce strong and durable salmon bricks.)

Other names of classifications are given common bricks, but the most important thing is to know the hardness and durability of the brick before it is laid. Hard and durable brick should be laid in the exterior surface of the wall exposed to the elements.

In general, common brick is used in the backing courses for other kinds of brick. The harder, more durable common bricks are always preferable to the softer, less durable bricks, even for backing. High grades of common brick are sometimes used satisfactorily for exterior tiers in walls not visible from the street or in walls that are to be stuccoed. Also, selected common bricks that are well burned and have pleasing uniform colors of red or tan are used in the visible exteriors of walls with surprisingly good results.

The poorer grades of soft and salmon brick should only be used as backup bricks in nonbearing walls and partitions not exposed to weather. The good grades of common brick work well in walks, piers, garden walls, columns, steps, and other similar masonry construction.

FACE. Face brick is made of selected materials that are burned under controlled conditions so that hardness, size, strength, color, texture, etc, will be uniform, and all brick of high grade classification. These have surface markings or scorings to give them a pleasing appearance.

Face brick is generally used for exterior tiers in walls exposed to the weather, particularly those visible from the street. It is also used for veneering, walks, steps, garden walls, etc, where beauty is desired and expense is no object.

PRESSED. Any brick made by the dry-press process is called pressed brick. The bricks may be common, faced, or other kinds of bricks depending upon the clay, coloring, and burning. (Some clay mixtures must be processed dry to avoid cracking or

crazing the surfaces of the bricks during burning.) Only the better grades of common brick are pressed brick. Manufacturers press many of their face brick.

Pressed bricks are excellent for the exterior tiers of brick in outside walls. Burned pressed bricks are uniform in size and adhere more closely to standards of size, and are used in structures built to exact dimensions.

FIREBRICK. Firebrick is made from special clays which withstand high temperatures without cracking, and are commonly used to line interiors of furnaces, fireplaces, and other surfaces exposed to extreme heat.

GLAZED. A glazed brick is one that has had one or more surfaces covered with a transparent glass-like vitreous coating. When a colored coating is desired, a vitreous enamel of the desired color is used. Glazed brick are used in exterior tiers of walls or partitions in bathrooms, dairies, hospitals, kitchens, and other places where cleanliness and ease of cleaning are essential.

IMITATION. Imitation brick is similar in size and shape to clay brick, but is made primarily of portland cement and sand. Imitation bricks are not burned, and have the same qualities of good cement mortar. The bricks may be used where common, faced, and pressed bricks are used.

CUTTING MASONRY

Masonry Saw

A masonry saw is used to cut block, tile, stone, and brick to exact size. Follow these operating instructions:

1. Safety Precautions
   a. Remove all jewelry.
   b. Check the electric motor for ground connection.
   c. Keep hands away from saw blade.
   d. Keep work area free of debris.
   e. Wear face shield or goggles while operating saw.
2. Preoperational check
   a. Check tightness of blade and movability of table.
   b. Check electric motor for proper grounding and for frayed cords and connections.
   c. Check water supply.
   d. Check water pump for operation.

3. Operational Check

   a. Turn power switch to correct voltage, 110 or 220.

   b. Turn water on for blade.

   c. Proceed to cut material slowly and smoothly without jerky motions.

4. Postoperating check

   a. Shut off motor.

   b. Shut off water.

   c. Visually inspect machine.

   d. Clean and service as required.

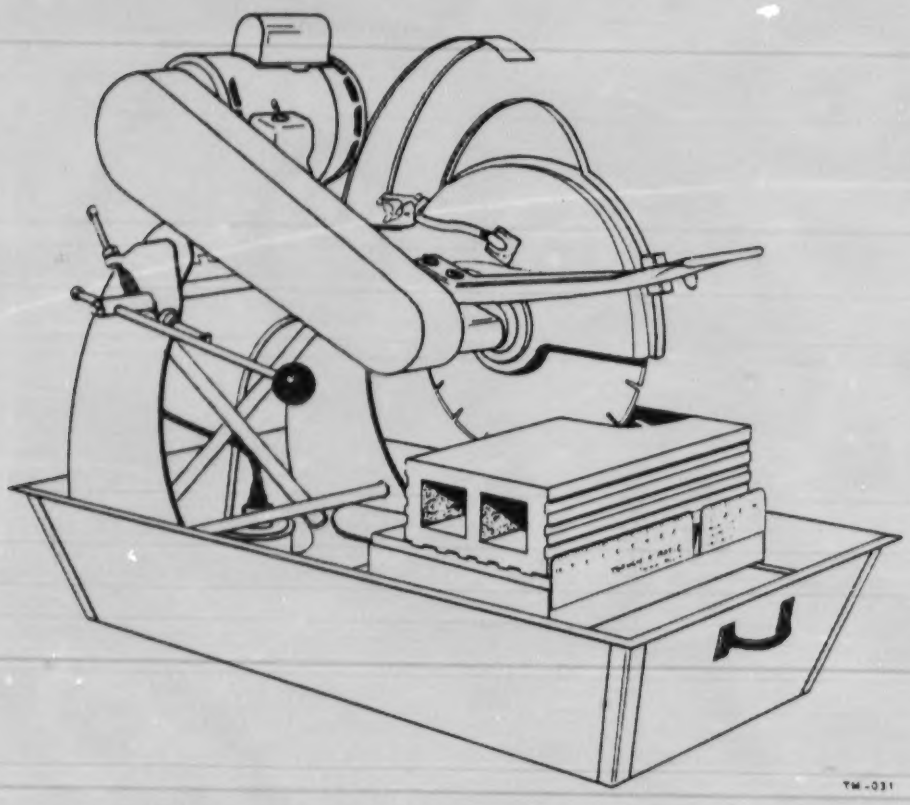


Figure 50. Masonry Saw

BRICK HAMMER

Splitting Brick

The initial line of split is made by hammering lightly around the brick with the head of the brick hammer to assure a better split. The continuation of hammering around the brick following the line of indentation will cause the brick to split. Figure 51 shows how a brick is split with a brick hammer.

Figure 51. Using a Brick Hammer to Split Brick

Trimming Brick and Block

Block and brick may be trimmed with the peen of the brick hammer by using short, sharp blows. Figure 52 shows how the uneven face of a split brick is trimmed with the peen of a brick hammer.

Figure 52. Trimming a Split Brick

BRICK SET

Cutting Brick and Block

USING A SET. A brick set may be used to cut a block and brick square across or at specified angles. The brick set is placed on the brick with the beveled edge of the tool toward the portion of the brick being cut off. When the set is placed in the correct position, it is struck with a brick hammer as shown in figure 53. Marking and cutting the brick and block on all four sides obtains smoother cut edges.

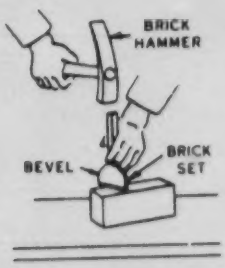


Figure 53. Cutting Brick with a Brick Set

Trowel

USING A TROWEL. The trowel is sometimes used instead of the brick set to cut brick. It is used, to make square cuts of common brick or block. The trowel and the brick must be held in certain positions to successfully cut the brick. Figure 54 shows how the trowel and the brick should be held when cutting brick with a trowel.

Figure 54. Cutting Brick with the Trowel

Eye Safety

Not wearing eye protection while cutting masonry is the major cause of eye damage to the mason.

SUMMARY

There are many kinds of construction done with concrete materials; therefore, there are different types, shapes, and sizes of concrete blocks, structural tile, and stone to meet the various construction requirements. The selection of the proper blocks or stone is a problem of the architect or the structural engineer. It is your responsibility to know the various types so that you can be sure to use the proper block or stone as shown in the blueprints and specifications.

It is also your responsibility to know the various tools and their application to your job as a masonry specialist. Then use the proper materials and tools to complete the construction job to meet all specifications set by the architect or construction engineer.

All additional information can be found in CDC 55253, Masonry Specialist, Chapters 4 and 5, pages 42 through 67.

QUESTIONS

1. List five uses of concrete masonry blocks.

2. Explain briefly why masons need a spirit level of some type for doing their work.

3. What use does a mason make of a plumb bob?

4. Name five of the seven types of construction listed in this study guide.

5. List two reasons for the holes being in the blade of a mason's hoe.

6. What is considered the dimension of the ordinary brick? _____

7. What factors may cause brick to vary in size and quality?

_____

8. What makes the mortar hoe a unique tool? _____

9. What is the primary purpose of the spacing on modular rule? _____

_____

10. What is the purpose of a line block? _____

REFERENCES

1. AFM 88-1, Resources and Work Force Management

2. AFM 88-4, Maintenance and Construction Methods for Building and Structure

3. AFM 88-25, Guide Specifications for Military Family Housing

4. CDC 55253, Masonry Specialist

CONCRETE BLOCK CONSTRUCTION

OBJECTIVE

Upon completion of this unit of instruction you will be able to

a. Estimate the amount of materials required for a masonry project.

b. Lay out a block wall for a one story masonry structure.

c. Construct a block wall for a one story masonry structure.

INTRODUCTION

No construction material has developed so rapidly over the past 25 years as concrete blocks. The introduction of new materials and improved methods of manufacturers has created an immense market for these units.

It is estimated that approximately 50 percent of exterior walls today are constructed of concrete block units. The use of high production machinery, capable of making up to a thousand blocks per hour, along with new materials, has increased the demand for their usage. Block and tile are popular because they are easy to handle, easy to lay, and are economical. A concrete block wall can be constructed in much less time than other construction methods. It is very durable, light in weight, ratproof, fireproof, rustproof, and termite proof and is not damaged when in contact with water or chemicals. Although structures of great strength and durability can be constructed of stone, stone construction is usually limited to uses where appearance is important.

This study guide is introductory in nature. More comprehensive information may be found in the references listed at the end of the text.

ESTIMATING MASONRY MATERIAL

Use the following tables when estimating the number of blocks and the amount of mortar required for a specific masonry project.

Block Size

Whole block	8" x 8" x 16"
Half block	8" x 8" x 8"
Partition block	4" x 8" x 16"

Block Shape

Corners
Stretchers
Half
Partition

Types of Blocks

Concrete
Cinder
Clay
Structural tile

Estimating the Number of Blocks Required

In estimating the number of whole blocks needed for a specific project, use the following formulas:

(1) Length

Multiply the length of the building (in feet) by 3/4. It takes three blocks 16 inches long to cover 4 feet.

Example: No. 1

How many 16" blocks will it take to cover 96 feet?

96 x 3/4 = 72 blocks needed.

(2) Height

Multiply the height of the building (in feet) by 3/2. It takes three blocks 8 inches high to make a 2-foot wall.

Example: No. 2

How many blocks will it take to make a wall 10 feet high?

10 x 3/2 = 15 The wall will be 15 blocks high.

QUESTION

How many 8 x 8 x 16 blocks will it take to make a wall 96 feet long and 10 feet high?

ANSWER:

There will be 72 blocks in each line (Example No. 1) and there will be 15 lines (Example No. 2). Therefore, by multiplying the number of blocks per line (72) by the number of lines (15) we can determine that it will take 1080 blocks to make the wall.

72 x 15 = 1080 blocks needed.

Estimating the Amount of Mortar Required

The ideal recommended mortar mixing is one sack of masonry cement to three cubic feet of sand. In the dry state this mix has a volume of 4 cubic feet. By adding one gallon of water to the mix it will reduce in volume to 3 cubic feet.

This three cubic feet of mortar will lay approximately 35 full size blocks.

Example: No. 3

How much mortar is needed to lay 1080 full size blocks?

$$35 \overline{)1080} \quad 31 \text{ one sack mixes.}$$

Estimating Man-Hours needed

One mason with a helper can lay approximately 150 full size concrete or 175 full size cinder blocks in 8 hours.

Example: No. 4

How long will it take one mason (with a helper) to lay 1080 full size concrete blocks?

$$150 \overline{)1080} \quad 7.2 \text{ hours needed}$$

LAYOUT FOR BLOCK WORK

The mason must do considerable planning before he starts any masonry project. He must determine the number of blocks needed, the amount of mortar required and how long it will take to do the job. In addition to these items, he also needs to determine where to start the construction and how much mortar to place between each block to make the length and height come out a full or half block.

Modular Design

Modular design is the art of determining how much mortar to place in joints and between courses to make the finished line or course come out an even full or half-block. There are two types of rules (see figures 55 and 56), used for this purpose. The spacing rule is used with standard brick and the modular rule with engineer's, economy and modular roman blocks.

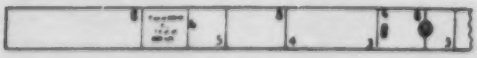


Figure 55. Modular Rule

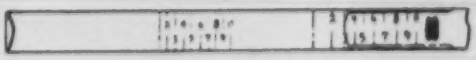


Figure 56. Spacing Rule

Story Pole

Before starting actual instruction, a mason should prepare a story pole. (See figure 57.) The story pole should be prepared on a piece of wood about 1/2 inch thick, 1 inch wide and a foot or two long. The marks should indicate the top of each layer of blocks. A story pole can also be used to indicate the height of window sills, doors, and other openings.

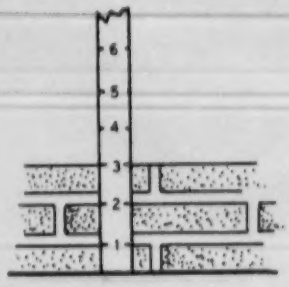


Figure 57. Story Pole

Layout Procedures

The first step to take is to lay out the corners. To locate the corners of a wall, drop a plumb bob from the lines on the batter boards (where the lines cross) to establish the corner points. Corners being located in this manner are shown in figure 58. You should first mark these points on the foundation with a chisel or a chalkmark, and then strike a chalkline from corner to corner. A combination self-chalking line box and plumb bob is shown in figure 59. The chalkline establishes the outer edge of the first course of brick, and the length of the course.

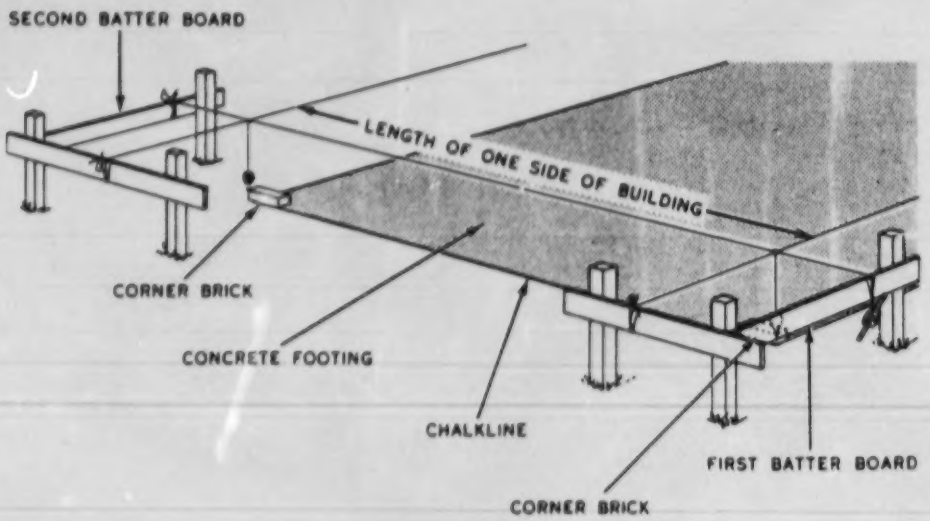


Figure 58. Corner Location

Chasing Out the Bond

The bottom course in the first tier of blocks should be laid out dry in bond, the length of the wall to be constructed. This procedure is often referred to as chasing out the bond. It enables the mason to determine the exact number of blocks required. The first block is placed on the foundation where the corner will be. A rule or stick,

Figure 59. Self-Chalking Line Box and Plumb Bob

the thickness of the mortar joint, is placed against the first or corner block and the second block put in position against the rule or stick being used as a mortar joint gauge. The process is repeated until the first course of the wall is laid out. The last whole block in the wall should fit within the outer dimension of the foundation. Cross joints or head joints may be adjusted slightly for thickness when absolutely necessary.

When the bond is laid out, each mortar joint should be marked with chalk on the edge of the foundation. If the job is not too large, the bond may be laid out around the complete foundation. When all joints have been on the foundation, the job is ready for mortar for the first bed joint to be spread on the foundation.

Openings for doors and windows can be left out and marked on the foundation for future reference.

Block Corner Construction

Mix mortar to the recommended quantities of one sack masonry cement for three cubic feet of dry sand, then add enough water to obtain a workable mixture.

SURFACE AND BED FOR MORTAR. Sweep the foundation off with a good broom, then rinse off with water to insure a good clean surface for a better bonding of blocks to the foundation.

APPLYING MORTAR. Mortar is first spread on the foot or foundation for the corner unit. The mortar is spread to provide a bed for the shell of the unit only. There should be no mortar under the webs of concrete block or tile. Figure 60 shows mortar spread on a footing or foundation preparatory to laying a corner unit.

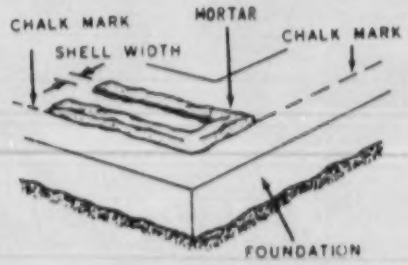


Figure 60. Spreading Mortar for First Corner Unit

BUTTERING STRETCHER. The end of the wall unit stretcher which will adjoin the corner block is buttered before it is placed on the mortar bed. The mortar should be buttered and spread on both lugs of the block until it is about 1 inch thick. Figure 61 shows the buttered end of the stretcher.

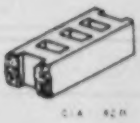


Figure 61. Buttered End of Wall Unit Stretcher

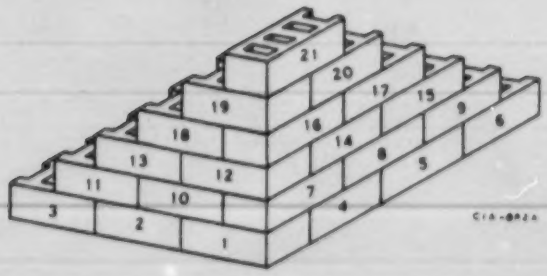


Figure 62. Correct Numerical Order of Laying Up the Corner

POSITIONING BLOCKS. Figure 62 shows the correct procedures used in laying block for the corner. Spread the mortar in the direction of (1, 2, 3). Use enough mortar to place three blocks as a full unit. Then level the unit of three blocks (1, 2, 3) and plumb the unit on each end. Then straightedge the unit of blocks. Repeat the same procedure for the following units: (4, 5, 6), (7, 8, 9), (10, 11), (12, 13), (14, 15), (16, 17), (18), (19), (20), (21).

LAYING THE FIRST CORNER BLOCK. The corner block (Number 1, figure 62), should be laid on the mortar with its face edges on the chalk mark. Be sure to lay the corner block and all other blocks with the thicker edge of the face shell up. This provides for a larger mortar bed for the next course of block. The block is pushed down until the bed joint is the thickness specified. Excess mortar is cut off with the trowel, and the corner block is checked for alignment. The block should be laid lever and be made square with the chalk marks on the footing or foundation.

LAYING STRETCHER. The buttered stretcher is placed, pressed and shoved, and pressed down until the head and bed joints are the correct thickness. Excess mortar is cut off with the edge of the trowel blade after the stretcher is laid.

LAYING REMAINING STRETCHERS IN LEAD. The remaining stretchers are buttered and laid in the same manner as the first stretcher.

Horizontal and Vertical Alignment

Figure 63 shows the corner block in position on the footing or foundation, with dotted lines indicating the positions of the level (sometimes called plumb rule) for checking the levelness of the block. Lines A and B indicate the positions in which the level should be placed for checking the levelness of the corner unit. Any adjustments, such as tapping or pressing down, required to bring the block into alignment should be made before the mortar sets to any extent. Otherwise the bond between the mortar and the block will be broken.

LEVELING STRETCHER. The stretcher is check for levelness in the same manner as the corner unit, and any adjustment of the block is made to make it level.

LEVELING LEAD. The lead (consisting of blocks (Numbers 1, 2, and 3) are checked for levelness, and the necessary adjustments to align the blocks are made.

STRAIGHTEDGING LEAD. The completed first course lead, on the line side, should be straightedged by placing the straightedge along the face of the lead near the top edges of the blocks. (See figure 63.)

Figure 63. Checking the Levelness of a Corner Unit

LAYING OTHER SIDE OF FIRST COURSE. The stretcher or stretchers (in this case, numbers 4, 5, and 6, figure 62) are laid in the same manner as the other stretchers.

SQUARING CORNER. The first course in the corner lead should be checked with a square to see that the line lead and return lead form a square corner. The leads should also be checked to see that the units are aligned with the chalk mark on the footing or foundation.

TESTING HEIGHT OF COURSE. The height of the first course should be checked with the story pole to insure that it is the correct height.

SPREADING MORTAR. The next step in raising the first corner is to lay the second course of blocks. Mortar is spread on the shell edges of the corner block and the first stretcher (numbers 1, 4, 5, and 6, figure 62).

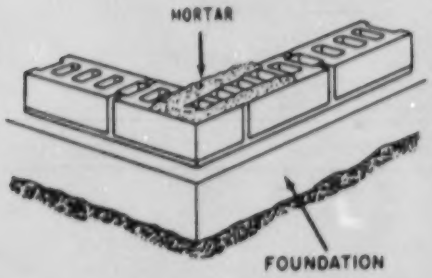


Figure 64. Spreading Mortar for Second Corner Unit

Figure 64 shows mortar spread on these units preparatory to laying the corner block (number 7, figure 62) of the second course.

LAYING CORNER BLOCK IN SECOND COURSE. The second corner unit is placed on the mortar, pressed and shoved and pressed down until the bed joint is of the correct thickness. The corner unit is block No. 7 shown in figure 62. Note that it is in a position reverse from that of the corner unit in the first course. The mortar is cut off prior to leveling the block.

LEVELING CORNER BLOCK IN SECOND COURSE. The corner block is checked for levelness in the same manner as other blocks were checked. Any adjustments required to bring the block into proper alignment should be made during the check.

PLUMBING THE CORNER BLOCK. After leveling, the corner block should be checked with a level or plumb rule for plumbness. The level should be placed in the positions indicated by lines D in figure 65.

ADJUSTING CORNER BLOCK. The second corner block is adjusted by tapping or pushing it down to make it plumb.

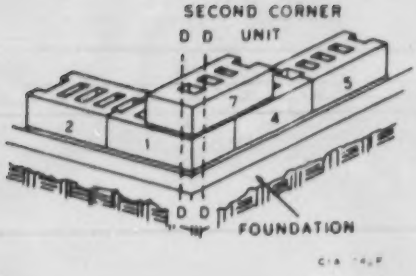


Figure 65. Plumbing the Corner

LAYING REMAINING STRETCHERS. The remaining stretchers (numbers 8 and 9, figure 8) in the second course are laid in the same manner as stretchers in the first course were laid.

LEVELING SECOND COURSE. The stretchers laid in the second course are leveled and adjusted, if necessary, to bring them into proper alignment. The leveling is done with the level as previously indicated.

PLUMBING SECOND COURSE. The second course is plumbed with the level to insure that it is in vertical alignment with the first course.

STRAIGHTEDGING SECOND COURSE. The second course is straightedged and the units aligned in the same way as the first course was straightedged. The straightedge should be positioned slightly above the bottom edges of the blocks.

TESTING HEIGHT SECOND COURSE. The second course is checked with the story pole to make certain that the course is the correct height above the foundation.

PLUMBING CORNER. The corner should be checked again, after straightedging and striking or tooling the mortar joints, to insure that none of the blocks have been moved out of position.

LAYING THIRD COURSE. The third course consisting of the corner unit and the stretcher or stretchers (in the case, blocks Nos. 12 and 13, figure 62, are laid in the same manner as similar blocks in the first course were laid.

TESTING THIRD COURSE. The third course should be checked for levelness, squareness, and plumbness in the same manner as accomplished previously on other blocks. The third course should also be checked for proper height above the foundation.

ADJUSTING THIRD COURSE BLOCKS. Concrete blocks which are to be adjusted, as a result of testing, must be moved while the mortar is still plastic. Blocks moved after the mortar has set causes the bond between them and the mortar to be broken. A bond, of this type, once broken will not reestablish itself.

There are several masonry construction features illustrated in figures 66 through 76. Study these pictures carefully as they will help you in learning to lay concrete blocks.

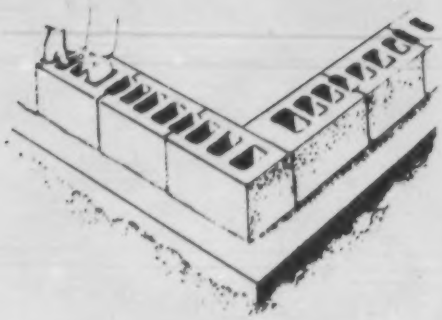


Figure 66. Stringing out Blocks

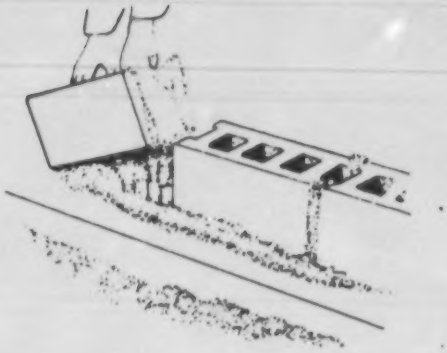


Figure 69. Blocks Buttered for Vertical Joints

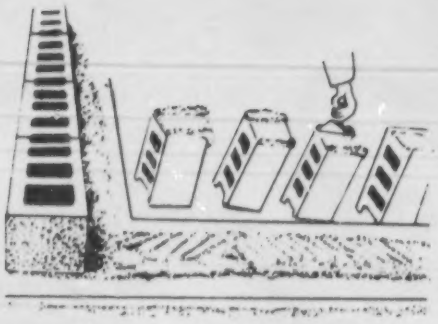


Figure 67. Spread and Furrow Mortar Bed

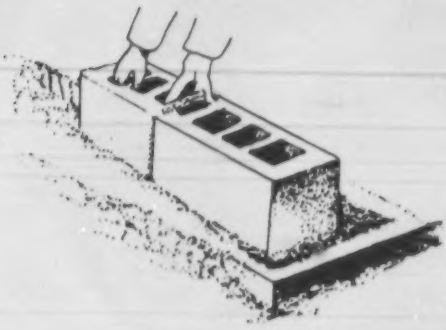


Figure 70. Positioning Block

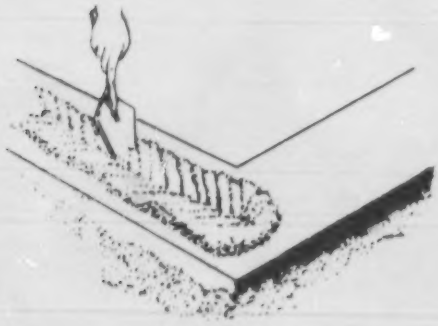


Figure 68. Position Corner Block

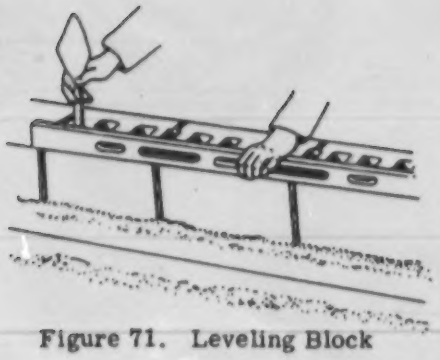


Figure 71. Leveling Block

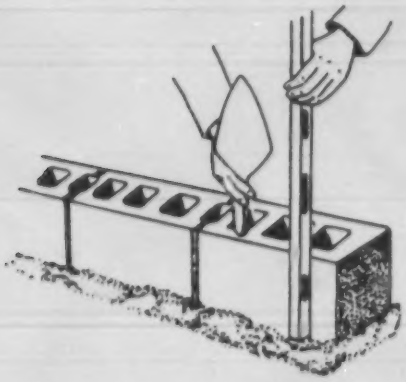


Figure 72. Plumbing Block

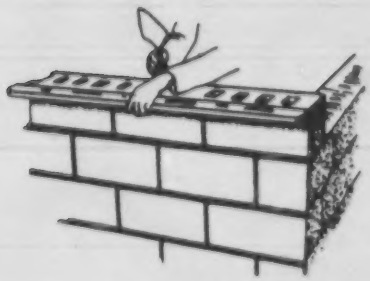


Figure 73. Aligning

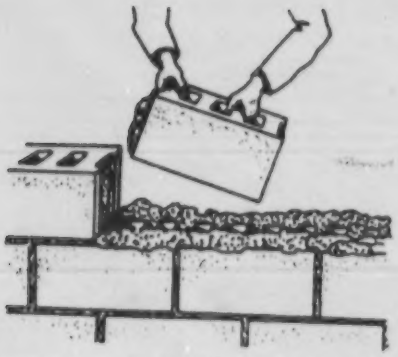


Figure 74. Vertical Joints

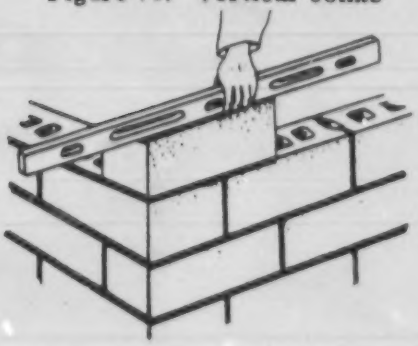


Figure 75. Leveling

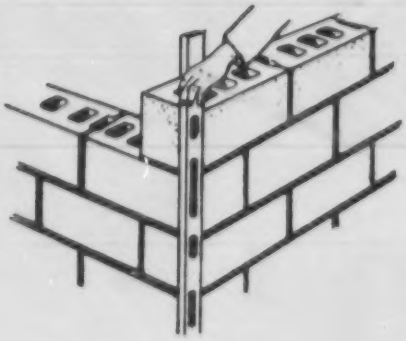


Figure 76. Plumbing

Shaping Mortar Joints

Mortar joints are finished by a process called stricking. Stricking does to a joint what troweling does to concrete. A masonry joint is ready to strick (finish) when the mortar is thumbprint hard.

BRUSHING-DOWN CORNER. The corner lead should be brushed down to remove particles of mortar and foreign matter from the blocks. Granules of mortar sticking to faces of the concrete blocks are brushed off before they harden to the extent that they are difficult to remove.

TOUCHING-UP JOINTS. Mortar joints should be examined at this time, and any holes should be filled and struck or tooled. Other defects in joints that have been previously struck or tooled should be smoothed out with the trowel or jointer.

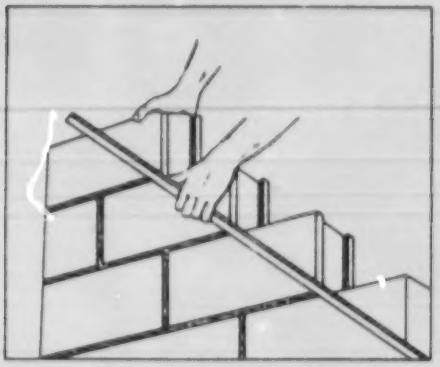


Figure 77. Checking Horizontal Spacing

When building corners, each course is stepped back a half block. You can check the horizontal spacing of these blocks by placing a straightedge diagonally across the corners of the blocks, as shown in figure 77.

RAISING SECOND CORNER. The second corner is raised in the same manner as the first corner. On the job, the second, third, and other corner leads may be raised at the same time that the first corner is raised. This depends upon the number of masons and apprentices working on the job.

FORMING CONTROL JOINTS. Control joints are used to control cracking in masonry walls. Control joints are continuous vertical joints built into walls at points where these stresses might concentrate. To form a continuous vertical joint, full and half length blocks are used.

Block Wall Construction

To fill in the wall between the corners, stretch a line from corner to corner (for each course) and lay each block with the top outside edge parallel to the line, as shown in figure 78.

Running a line from corner to corner identifies the top of the block for the course being laid. (See figure 78.)

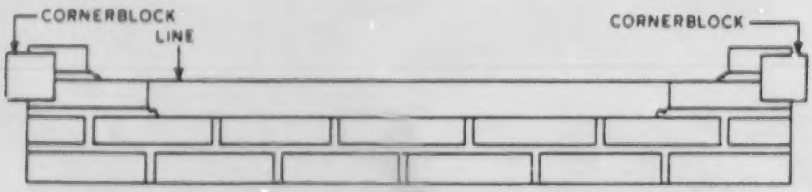


Figure 78

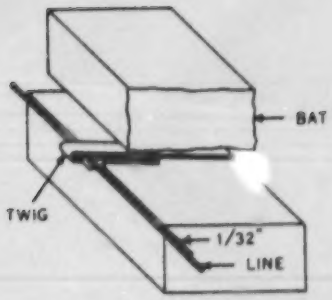


Figure 79. Intermediate Lead

The line should be fastened so that 1/32 inch exists between the line and the top outside edge of the blocks to be placed. The line must be tightly drawn to present a straight and level reference. If the wall is too long, then intermediate supports should be strategically placed to maintain line straightness (see figure 79).

Figure 79 illustrates the approximate position of the line to the block being placed.

SPREADING MORTAR. To eliminate the probability of the mortar stiffening and losing its plastic quality, never spread mortar too far ahead of the actual laying of the block. After laying each block, cut off all mortar extruding from the joint.

In some localities, depending upon climatic conditions and other criteria; a full mortar bed may be specified for all concrete block construction. In this case, place mortar on the cross webs of the block as well as the face shells.

LAYING BLOCK TO A LINE. Balance the block evenly in each hand (as illustrated in figure 80) and set it in place. Tap it gently to align it with the line. See figure 80.

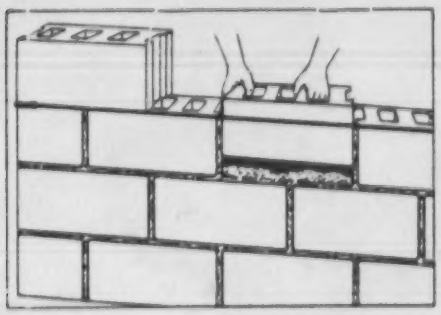


Figure 80. Laying Block to the Line

LAYING THE CLOSURE BLOCK. The closure block is the last block laid in a course, as shown in figure 80. To install the closure block, butter all four vertical edges of the block with mortar. Carefully lower the block into position making sure all mortar remains in position.

If walls and other structural details are properly planned, block cutting is held to a minimum; however, there are times when just part of a block will be needed. Cut the block with a broad chisel and a hammer. Score the block with the chisel where it should break, then use heavier blows until the block breaks.

Sometimes blocks need to be cut for concealed plumbing and electrical switch or outlet boxes. This cutting can be done by using a small cold chisel and a hammer. Score the outline of the hole, then strike heavier blows until the block breaks on the line. When using this method, use the part of the blade near the handle where it is stiffest. If accuracy is very important, use a masonry saw. Mark the lines on the block for the portion to be cut away, and place the block on the saw table in such a position to enable an accurate and safe cut.

TYING-IN INTERSECTING WALLS. When load bearing or nonloadbearing walls meet or intersect, they should be tied together with metal tie bars. See figure 81. An intersecting wall being tied together is shown in figure 82.

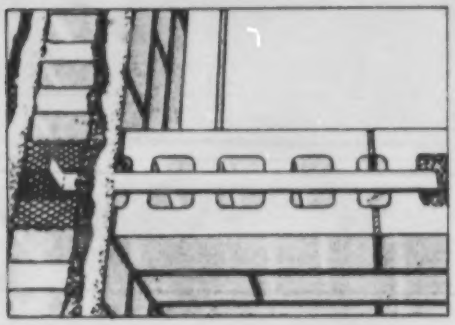


Figure 81. Metal Tie Bar

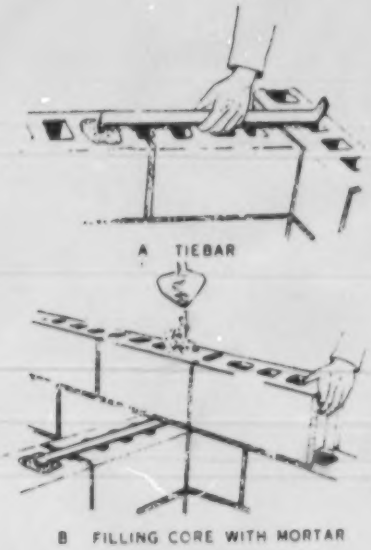


Figure 82. Tieing Intersecting Bearing Walls

INSTALLING ANCHOR BOLTS

After the concrete block wall has been completed some provision must be made to anchor the top of the building to the wall. The top is attached to or anchored by wooden plates fastened to the concrete block wall with anchor bolts. However, the size recommended is 1/2 inch in diameter and 18 inches long. The anchor bolts are usually placed in cores of the top two courses of blocks. After the anchor bolts are placed, fill the cores with mortar. (See figure 83.)

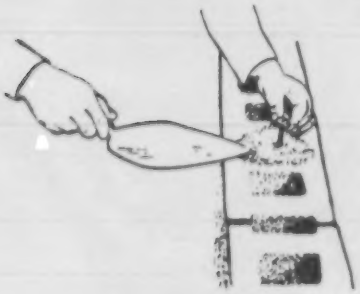


Figure 83. Setting Anchor Bolt

To retain the concrete or mortar in the cores, place a piece of metal lath in the second horizontal mortar joint (under the first two blocks in the second course from the top) and under the cores to be filled. The threaded end of the bolt must extend above the top of the block far enough to pass through the holes in the plate and receive a nut.

Laying Lintels

To support concrete block over openings, steel lintel angles are used. In some of the modern concrete block structures precast concrete lintels are used over openings. To uniformly distribute the lintel load, a full mortar bed should be spread over the lintel.

CORRUGATED METAL TIES

Anytime masonry material is used in veneer construction, some means must be made to bond the onside veneer with the structural parts of the building. Corrugated metal ties are used for this purpose. These ties are made from 16 or 18 gauge metal, about one inch wide and 8 inches long. These ties are installed as illustrated in figure 84.

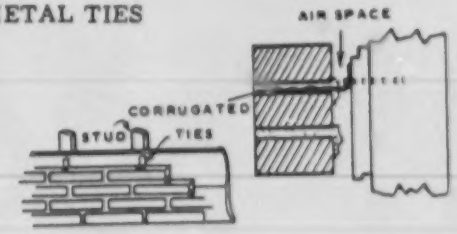


Figure 84. Installing Corrugated Ties

SUMMARY

It is important to learn proper blocklaying procedures as an apprentice masonry and concrete worker. The proper way to prepare a bed for mortar was also discussed. The method of spreading mortar for block construction varies considerably from that of spreading mortar for brick.

Getting the corners of a building started properly is one of the major steps in any masonry construction. Without the corners being started properly, the structure would lack strength and would tend to be a very unattractive unit when finished.

QUESTIONS

1. What bonding material is generally used in concrete block and tile wall construction?

2. What is the value of a story pole in concrete block and tile wall construction?

3. Why should a straightedge be placed diagonally across the blocks when raising a concrete corner?

4. When laying concrete block having a face shield thicker on one side than the other, which side of the block would be placed up? Why?

5. When is the best time to tool the mortar joints of a concrete block or tile wall?

6. For accurate cut of concrete blocks for plumbing, the mason should use the

_____.

7. Name three tools normally used to cut concrete blocks.

8. How many edges of a closure block are buttered?

9. When laying block or tile, the mortar should be used within _____ to _____ hours as the outside temperature is 78^{o} or above.

10. What is the maximum time for any mortar to be used after mixing, even with the cooler temperatures?

STONE CONSTRUCTION

OBJECTIVE

Upon completion of this unit of instruction, you will be able to

- use a construction drawing to estimate the amount of stone and mortar required to complete a masonry project.
- lay out a stone wall for a one story building and indicate the location and size of the window and door openings.
- construct a stone wall for a one story masonry building.

INTRODUCTION

Stone laying is perhaps the ultimate skill in masonry. A good stone mason is in great demand. It is a highly skilled art to select the stone, cut it, match it, bond it, and lay it so that the finished wall is both strong and beautiful.

Stone Size

Stone comes in many sizes. It would be impossible to estimate how many stone would be required for a given project. Stone is normally estimated by volume, either in cubic yards (27 cu ft) or by the perch (24 3/4 cu ft). The normal size of a perch of stone is 16 1/2 feet long, 1 foot high and 1 1/2 feet thick.

Stone Shape

Building stones may be left rough, they may be roughly squared and dressed before they are used, or they may be accurately cut and highly dressed. Before building stone is laid, it is sometimes necessary to face (chip) it with a facing or napping hammer so it will be uniform. Rough stones are used extensively for constructing walls of small buildings and for fences.

In many localities, stones are picked up off the ground and used for constructing buildings and other structures. These rough field stones produce the simple bond and pattern of rustic stone construction.

Types of Stone

There is a variety of types of stone used for building purposes. The main thing to consider when selecting stone is availability. It takes a lot more time and effort to lay stone than it does to lay blocks or bricks. Therefore, unless the stone is readily available and cheap, it is usually better to use blocks or brick.

Listed below are some of the types of stone that are used for building purposes.

Granite - This is a very hard, strong stone that makes a very good building material. However, it is so hard that it is difficult to cut and shape. Its use is not recommended for general construction but it makes an excellent background for carving and lettering.

Limestone - This stone is found in sheets. It is relatively easy to quarry, cut and shape and is used extensively in some areas.

Marble - This stone is as hard as granite but has a very pleasing appearance when polished. It is usually cut to exact size and used as a facing where appearance is a factor. Pure marble is white, streaked with veins of black, gray, green, red, or yellow.

Sandstone - This stone is soft and easy to work. It is used for the same purposes as limestone. Sandstone that is well cemented with silica is both durable and weather resistant.

Slate - This fine-grained stone can be easily split into thin slabs. It is used for roofing and flagstone flooring.

Mortar

A normal masonry mix (one sack of masonry cement to three cubic feet of sand) is usually used to lay stone. However, if a stronger mortar is required, use portland cement instead of masonry cement.

It is very difficult to estimate the amount of mortar needed to lay stone. A good thumb-rule to use is 9 cubic feet of mortar for each cubic yard of wall.

FOUNDATIONS AND BONDING

No wall or building is better than the foundation on which it is built. The footing or foundation is wider than the wall itself. The larger stones should be used in it to give the greater strength and lessen the danger of settlement. Footing stones should be as long as the footing is wide, when possible. The stones for the first course should be laid in a mortar bed of about two inches deep and all spaces between them filled with mortar and smaller stones.

It is also possible to construct a footing of concrete and reinforcing materials. This method will result in a better control of settlement as it would give a firm base.

Bonding in stone masonry is just as important as it is in block masonry and other types of masonry. To assume good bonding in stonework, the header stone must extend through at least two-thirds the thickness of the wall. There must be a header in every five square feet of foundation wall surface area. Vertical joints in a stone course must be staggered with the vertical joints in the courses above and below it. The lap of vertical joints must be at least four inches. The largest stones should be used in the lowest course. Stratified or laminated stones should be laid with the layers positioned flat or horizontally.

UNCOURSED RUBBLE

Uncoursed rubble, also called cobweb rubble, is a suitable bond for structures such as small buildings and fences. Figure 85 shows stone courses in uncoursed rubble bond.

Figure 85. Uncoursed Rubble Bond

RANDOM COURSED RUBBLE

The bed joints in this rubble bond begin to become distinguishable as the thickness of the stone becomes more uniform. Figure 86 shows stone courses in random coursed rubble.

Figure 86. Random Coursed Rubble

COURSED RUBBLE

The thicknesses of stones in coursed rubble bond are nearly uniform. This causes the bed joints to be more or less horizontal and parallel with each other. The faces of the stones should be hammer dressed, to some extent, as they are laid. This makes the vertical joints nearly plumb and uniform in stagger. Bond stones should be laid approximately every four feet in the course to improve the strength of the bond. Figure 87 shows courses of stone in coursed rubble.

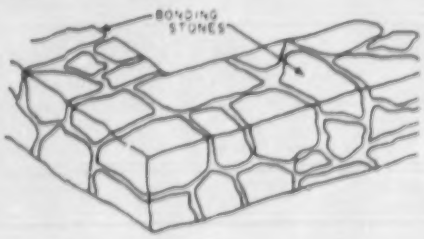


Figure 87. Coursed Rubble Bond

Random Rustic Rubble

The random rustic pattern is developed when uncoursed rubble bond is used in the wall or when a bond is veneered with field stones, beach stones, or cobblestones. Figure 88 shows rough-finished quarry stone laid in uncoursed rubble bond to form a random rustic rubble pattern.

Random Coursed Rubble

The random coursed rubble pattern is formed on the surface of a stone wall by using the random coursed rubble bond. Figure 89 shows rough-finished quarry stone laid in random coursed rubble bond to form a random coursed rubble pattern.

Placing Stone

Stone masons, called stone cutters, specialized in the art of cutting stone, work them to produce the various finishes, shapes, and sizes. Other stone masons, called stone setters, make a specialty of setting the prepared stones.

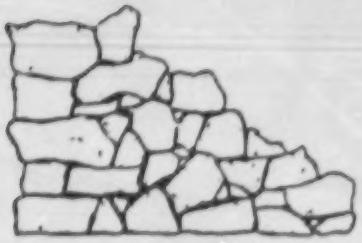


Figure 88. Random Rustic Rubble Pattern

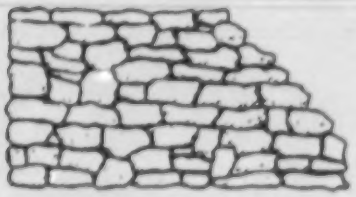


Figure 89. Random Coursed Rubble Pattern

Stone setters require special tools and equipment to place large stones on a prepared mortar bed. Small stones can be placed by hand by the stone setter; however, when placing some of the larger stones, the setter may require the help of an apprentice.

Laying Stone

Cement mortar is difficult to work; consequently, stone setters prefer a plastic cement-lime mortar. Any mortar, though, which contains ordinary cement may stain the stones. In the case of fine stonework, where staining is a problem, the architect or structural engineer will specify a nonstaining mortar. A nonstaining cement-lime mortar is obtained by substituting white portland cement for ordinary portland cement in a formula for cement-lime mortar suitable for stonework.

The mortar for stones is spread on the footing, foundation, or another stone course in the same manner as it is for blocks. (Great care must be taken to avoid smearing mortar containing cement on faces of the stones.) Also, in stonework, as in block work, it is important to have the joints completely full of mortar after the stone is laid. This is equally applicable to vertical or head joints to make them water resistant.

The sides of stones are normally coated with mortar after they are set in final position on the mortar bed. In the case of some irregularly shaped rubble stones, however, the surfaces which cannot be readily buttered after the stones are set should be buttered prior to being placed on the mortar bed. Mortar is cut off the mortar joints in the same manner as for blockwork. Mortar joints for stonework may be struck; however, tooled mortar joints are usually specified.

MAKING BED JOINTS. The thickness of bed joints will depend upon the stone used. When making bed joints, spread enough mortar on the stone below the one being placed to fill the space between the two stones completely.

MAKING HEAD JOINTS. Head joints in stone walls are made after three or four stones have been laid. You make these joints by slushing mortar (with your trowel) in the small spaces between the stones. Fill the larger spaces between the stones with small rock (gravel) and mortar. Be sure to form the head joints before the mortar in the bed joint has set.

POSITIONING STONE. A crowbar is used to position large stones after they are laid and a carborundum stone (rub brick) is used to smooth rough edges of the stone. The size of the stones should gradually diminish toward the top of the wall. Porous stones should be moistened before being placed in the mortar bed to prevent the stone from absorbing water from the mortar.

Bond stone (headers) should occur at least once in each 6 to 10 square feet of wall. Foundations must have a header in each 5 square feet. These stones pass all the way through the wall or at least two-thirds through the wall thickness.

Each head joint should be offset from adjacent head joints above and below as much as possible.

Stones are aligned using the same tools and methods as when aligning concrete blocks. Use a string, level and a story pole when laying stone.

ESTABLISHING CORNER LEADS. If the wall being constructed must be exactly plumb and erected to a line, corner posts of wood should be erected to serve the purpose of corner leads to hold the line in place. Because of the different shapes of stone, some parts of the stone will be farther away from the line than other parts. Each stone must be laid on its broadest face. If appearance is to be considered, the larger stones should be placed in the lower courses.

Anchor Bolts

Anchor bolts are often installed in stone walls. Such bolts may be L-shaped or the common square-headed bolt. Normally, the bolt is installed at the header. Unless the joint is extremely large, the corners of two of the stones diagonally from each other must be trimmed to prevent the bolt shank protruding through the joint. If an L-shaped bolt is installed, the bolt is turned so that one of the stones lies over the short leg of the L.

Rock Bolts

The only difference between anchor bolts and rock bolts is the way they are installed. Rock bolts are installed by drilling an anchor hole in a large rock and then setting (with cement) a large bolt in the hole. The bolt extends completely through the wall and acts as reinforcement.

Shaping Mortar Joints

It is much more difficult to shape joints in stonework than in brick or block work. The joints are odd sized and irregular. Therefore, it takes a lot of time and practice to shape the joints. The main tools used are the pointing and caulking trowel and a beader. The joint should be compacted to make it strong and watertight, then finished by striking and brushing.

SUMMARY

The same general rules apply to setting stone as laying block. Although stones are not all uniform in size, as block and tile, stone setters must pay close attention

to the bond to be certain that the finished wall will have strength and durability. He will also check the spacings very closely, since stones vary in width. Strength, durability and appearance must be kept in mind at all times.

QUESTIONS

1. What determines the length of a header stone?
2. Uncoarsed rubble is suitable for what type of structure?
3. How much should vertical joints overlap?
4. What should be the length of header stones?
5. Why should stones containing iron be avoided in stone construction?
6. What type of stone would be used as roofs?
7. What is the most common type of mortar used when laying stones?
8. Give another name for a header stone?
9. What is the physical condition of rough stone?
10. Where would the larger stones be used when building a stone wall?

REFERENCES

1. The Building Estimator's Reference Book, Frank R. Walker Co, 5th Edition
2. CDC 55253, Masonry Specialist

BRICK CONSTRUCTION

OBJECTIVES

Upon completion of this study guide, you will be able to

* estimate the number of bricks and the amount of mortar required to complete a masonry project.
* lay out a brick wall for a one story brick building and indicate the location and size of the window and door openings.
* construct a corner and wall.

INTRODUCTION

The bricklayer is considered the master of the mason profession. Bricks are small and a bricklayer must have great skill to be able to place and bond brick to make a strong, durable, and attractive structure.

Brick, used either as a load-bearing wall or as a veneer over another surface must be laid out and bonded properly if the structure is to properly serve its design function.

Layout and bonding techniques have been discussed in previous lessons. This lesson will be concerned with the erection of a brick structure.

ESTIMATION FOR BRICK AND MORTAR

Brick Size

The ordinary brick is a unit of clay approximately 2 1/4 by 3 3/4 by 8 inches in size that has been air-dried or burned. A portion of a brick is commonly called a bat or brick bat. More specifically one-half of a brick is known as a 4 1/2-inch bat. Any length of brick that is shorter than full length, but longer than 4 1/2-inch bat is known as a three-quarter bat.

There are two standard sizes recommended for ordinary brick. Common brick and rough-faced should be 2 1/4 by 3 3/4 by 8 inches. That is, a brick this size is 2 1/4 inches high or deep, 3 3/4 inches wide, and 8 inches long. Smooth-faced brick or pressed brick should be 2 1/4 by 3 7/8 by 8 inches. The size of the brick will vary slightly from these sizes because of shrinkage during the burning process. Aside from the two sizes mentioned above, brick are, however, made in other sizes. Fire-brick is ordinarily made 2 1/4 by 4 1/2 by 9 inches in size.

Bricks come in various shapes for various purposes. Some of the most common shapes of a brick are illustrated in figure 1.

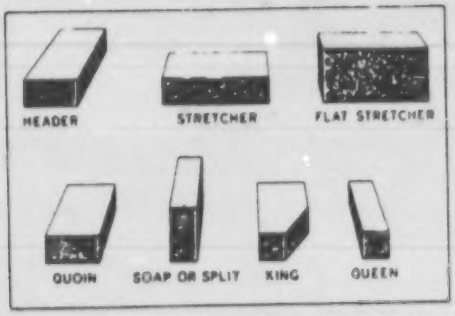


Figure 90. Brick Shapes

Brick Position

It is necessary to place brick in different positions for different purposes. Figure illustrates ways of placing bricks. The soldier course is used over door and window openings. The rowlock course is used for window sills.

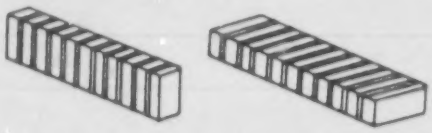


Figure 91. Brick Positions

Quantities of Brick

The most accurate method of estimating brickwork is to determine as nearly as possible the actual number of brick to be used. This is done by obtaining the thickness, height, and length of each wall and determining the number of square feet of surface on one side of the wall. Then the number of brick in one square foot of wall thickness should be counted and the figure multiplied by the number of square feet of wall surface. The square footage of opening must be deducted from the total amount of wall surface.

Brick in objects such as chimneys and fireplaces containing voids (hollows, depressions, and recesses) may be best estimated by figuring the wall as being solid and determining and subtracting the sum of the voids from that figure.

Estimated values taken from estimation tables will be accurate and very helpful when the specifications and conditions upon which the table is based are equivalent to those of the job for which the materials are being estimated. In other words, numerous tables must be available to provide an accurate value for differences in brick size, joints, bonds, patterns, wall thickness, etc. Such tables are found in reference books on estimating building construction.

The common brick required per square foot of different wall thickness, having 1/4-inch vertical joints are shown in figure 92.

Wall Thickness		Bed Joints					
Inches	Brick	1/8"	1/4"	3/8"	1/2"	5/8"	3/4"
4-4.5	1	7.3	7	6.7	6.3	6.1	5.8
8-9	2	14.7	14	13.3	12.7	12.2	11.6
12-13	3	22.0	21	20.0	19.0	18.3	17.4
16-17	4	29.3	28	26.7	25.3	24.3	23.2
20-21	5	36.7	35	33.3	31.7	30.4	29.0
24-25	6	44	42	40.0	38.0	36.5	34.8

Figure 92. Common Brick for a Square Foot of Wall

The modular brick required per square foot of different wall thickness are shown in figure 93.

Size Brick	Courses (Heights)			Joints	Wall Thickness		
Inches	Inches	Brick	Height	Width	4"	8"	12"
2 1/8 X 3 1/2 X 7 1/2	8	3	2 2/3"	1/2"	6.8	13.5	20.3
2 1/4 X 3 5/8 X 7 5/8	8	3	2 2/3"	5/12"	6.8	13.5	20.3
2 5/16 X 3 5/8 X 7 5/8	8	3	2 2/3"	3/8"	6.8	13.5	20.3
2 1/2 X 3 1/2 X 7 1/2	12	4	3 "	1/2"	6.0	12.0	18.0
3 1/2 X 3 1/2 X 7 1/2	12	3	4 "	1/2"	4.5	9.0	13.5

Figure 93. Modular Brick for a Square Foot of Wall

To determine the number of brick needed to build a wall, multiply the length by the height and this will give you the total number of square feet of surface. Using ordinary brick 2 1/4-inches high, 3 3/4-inches wide, and 8-inches long, you will find that it takes about seven bricks (using 1/4-inch mortar joint) to cover 1 square foot. We will figure eight bricks, and this will allow for breakage and cutting brick. You multiply the total number of square feet by the number of brick needed to cover 1 square foot, and this will give you the total number of brick needed for the surface.

Let's say, for instance, that we are constructing a partition wall 20-feet long, 6-feet high, and 4-inches wide. By multiplying the length (20 feet) by the height (6 feet), and you will have 120 square feet of wall surface. By multiplying 8 (the number of brick needed to cover 1 square foot) by 120 square feet, you will get a total of 960 bricks. This is the number of brick needed, including 1/4-inch mortar joints and breakage to complete the job.

If the wall were 8, 12, 16, etc, inches wide, you would have to multiply 960 by the number of brick in the width of the wall. In other words, if the wall were 16-inches wide (4 courses wide), it would take 4 x 960 = 3840 bricks to complete the wall.

If the brick wall or building has any openings, such as doors and windows square footage of the openings must be deducted from the total amount of the wall surface.

Volume of Mortar

The ideal masonry mix is one sack of masonry cement to three cubic feet of sand. One sack masonry mix dry makes a volume of 4 cubic feet (1 cubic foot of mason cement and 3 cubic feet of sand). When one gallon of water is added to this mixture, it consolidates to 3 cubic feet of mortar. One sack masonry mix (3 cubic feet of mortar) will lay approximately 200 face bricks.

To determine how much mortar is needed, divide the total number of bricks required (3840) by 200. Your answer (20) (always use full sacks) is the number of one-sack mixes required for this job.

Ordinarily one yard of sand and the usual amounts of cementitious materials and water will make approximately one cubic yard of mortar. Factors such as the size and shape and masonry units, the thickness of mortar joints, and the type of bond, however, will affect the requirements for mortar. Consequently, unless the requirements are the same as the conditions specified for a proportions table, the values given in the table can be nothing more than approximations. Also, because of differences in cementitious materials and aggregates, no accurate set of values can be tabulated for all conditions.

Proportions of mortar, for making one cubic yard of mortar (using loose, damp sand), which have been tested, tried, and found to be generally good, are shown in figure 94.

Mix Proportions Formula	Cement (Wt - Vol)				Lime (Wt - Vol)				Job Sand	
	Portland		Masonry		Hydrated		Quicklime			
	Lbs	Bags	Lbs	Bags	Lbs	Bags	Lbs	Bags	Lbs	Cu Ft
Very strong 1:1/4:3	839	8.9			89	1.8	48	0.6	2142	26.8
Strong 1:1:6	442	4.7			235	4.7	127	1.6	2256	28.2
Average 1:2:9	296	3.1			315	6.3	170	2.1	2270	28.4
Weak 1:4:15	178	1.9			379	7.6	205	2.6	2274	28.4

Figure 94. Cement-Lime Mortars

To give you some idea of the volume of mortar required by the brick mason to lay masonry units (excluding covering the inside face), a few values of a general nature are suggested in figure 95.

Building Brick	(1/2" Joints)	Glazed Brick		
Bond	Mortar (Cu Ft)	Size (Inches)	1/4" Joints	3/8" Joints
Flat stretcher	1.2	2 1/4 X 8	0.6	0.9
Edge stretcher	0.8	5 X 8	0.8	1.2
Header	1.5	5 X 12	1.0	1.5
Rowlock	1.5			
Soldier	1.2			

Figure 95. Mortar for 100 Bricks

Labor Estimation

It's very difficult to correctly estimate the amount of labor to lay a brick wall. The time varies with the thickness and height of the walls, as well as the type bond used and the weather conditions. A man can lay more bricks on a nice warm day than he can on a cold, windy day with sand blowing in his face all the time.

Normally, a highly skilled mason should be able to lay 600 to 800 standard bricks in an 8-hour workday.

Layout for Brick Work

The first step to take is called chasing the bond, or measuring the bond. This consists of laying out the first tier or course of brick, without mortar, the length of the wall to be constructed. To chase (measure) the bond, place the first brick on the foundation where the corner will be located. Then place a rule or stick, the desired thickness of the vertical mortar joint, against the corner brick and place the second brick in position against the rule or stick.

Follow this process until the first course is laid out. The last whole brick in the wall should fit within the outer dimension of the foundation. If the last brick fails to fit by 1 or 2 inches, you can adjust the thickness of the head joints accordingly. If the corner brick fails to fit by 4 inches or more, use a whole brick on the corner and cut a brick of the proper size to use as a closure, two or three bricks back from the corner.

MARKING THE HEAD JOINTS. After laying out the bond, chalkmark the position of each head joint on the edge of the foundation. If the job is not too large, you can lay out the bond around the complete foundation. After marking all the head joints on the foundation, you can establish the leads.

Spacing Rule

With a spacing rule, a mason can tell how much mortar he should use with standard sized brick to construct uniform mortar joints and courses of specified thickness. Figure 96 shows an aluminum spacing rule. Some spacing rules are made of wood.

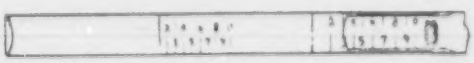


Figure 96. Spacing Rule

Modular Rule

This is an aluminum rule similar to the one to the right, but calibrated for Engineers. Economy, and Modular Roman, as well as for standard brick. Figure 97 shows an aluminum modular rule.

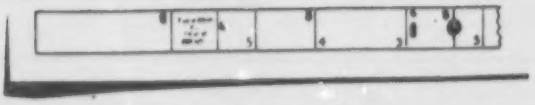


Figure 97. Modular Rule

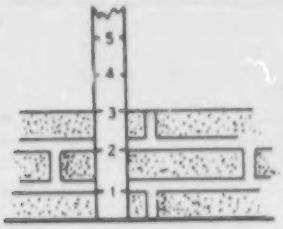


Figure 98. Story Pole

Story Pole

Mortar joint thickness is specified by the architect or structural engineer in the set of building plans. The brick mason lays out the height of each course (including the bed joint) on a strip of wood called a story pole or rod, so that the height of each course may be checked against the rule as the brickwork progresses. Figure 98 illustrates how a story pole is used.

Laying Out the Bond

Eight-inch brick walls are used in many small structure one or two stories in height. Under normal load conditions, they are thick enough. This is, however, for the architect to decide. Several bonds for eight-inch walls are shown in figure 99.

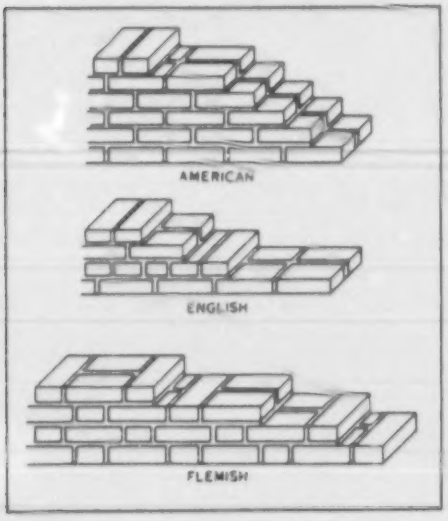


Figure 99. Bonds for Eight-Inch Walls

The bottom course in the first tier of bricks should be laid out, in bond, the length of the wall to be constructed. This procedure is often referred to as chasing out the bond. It enables the bricklayer to determine the exact number of brick required to lay out a tier of brick. The first brick is placed on the foundation where the corner will be. A rule or stick, the thickness of the mortar joint, is placed against the first or corner brick and the second brick put in position against the rule or stick being used as a mortar joint gauge. The process is repeated until the first course of the wall is laid out. The last whole brick in the wall should fit within the outer dimension of the foundation. Cross joints or head joints may be adjusted slightly for thickness when absolutely necessary.

When the bond is laid out, each mortar joint should be marked with chalk on the edge of the foundation. If the job is not too large, the bond may be laid out around the complete foundation. When all joints have been spotted on the foundation, the job is ready for mortar for the first bed joint to be spread on the foundation.

A line is stretched from one end or corner of the foundation wall to the other to act as a guide in keeping the wall straight. The first portions of the wall to be laid are called leads. These are raised at the ends of corners of the wall and at intermediate points in between, when the distance between corners is long. The leads establish the bond and pattern, the brick are laid between (filled-in) the leads in the same bond and pattern.

Masonry Terms

The masonry field (like all crafts) has certain words and terms that mean specific things to the mason. To be able to communicate with other masons, you must know the meaning of these terms. Some of these terms are explained and illustrated in figures 100 and 101.

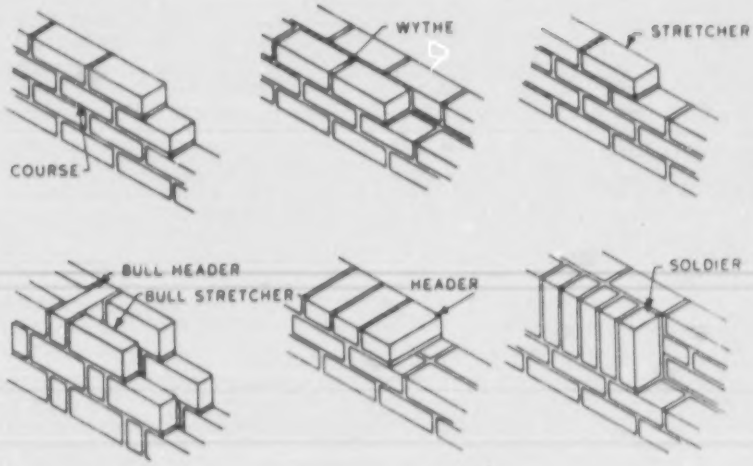


Figure 100. Masonry Units and Mortar Joints

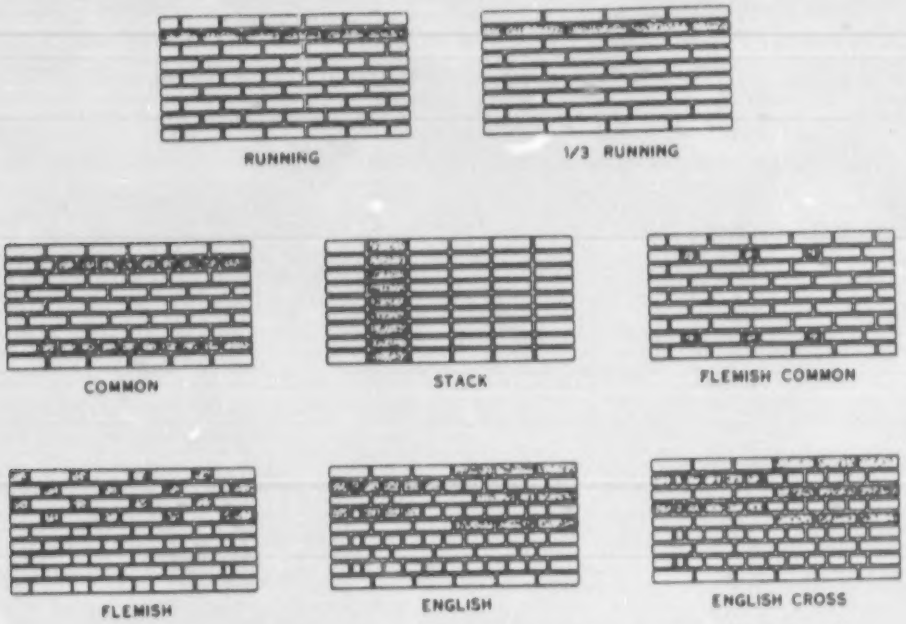


Figure 101. Some Types of Brick Masonry Bond

BONDING BRICK

The purpose of bonding brick in masonry work is to make the brickwork strong, solid, and durable. To do this it is necessary to place the brick in such a manner that they are all tied together in a cohesive mass. Mortar joints tie all brick together to some extent, but unless the bricks are placed to form the proper bond, the structure will not have the strength to support heavy loads. Bonding or breaking joints is accomplished by lapping one brick over two bricks in the course just below it. Figure 102 shows how one header rests over two stretchers in the course below; also, how one stretcher rests over two headers in the course below.

Lap

Since the brick of one course must overlap the brick in another course, the natural consideration is how much should they lap. In bricklaying, the practice is to make a brick lap other bricks 1/4, 1/3, 1/2, or 3/4 of its length. A brick should not lap another brick less than 1/4 brick length. Figure 103 shows how mortar joints are broken by lapping the bricks.

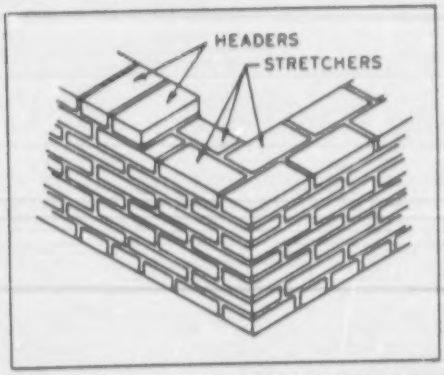


Figure 102. A Correctly Bonded Brick Wall

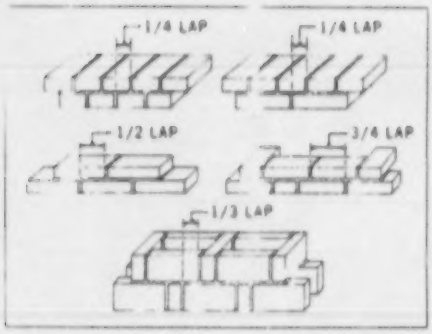


Figure 103. Lapping Brick

It is necessary in bricklaying to give special attention to maintaining lap. As work progresses, lap may be lost because of irregularities in the size of the brick and vertical mortar joint thickness, unless special attention is given to maintaining lap. Each vertical joint should be kept perpendicular or directly over the vertical joint two or more courses below. This process of keeping vertical joints perpendicular is called keeping the perpends. Sometimes it is necessary to use quoins, bats and closers to maintain the lap (see figure 104).

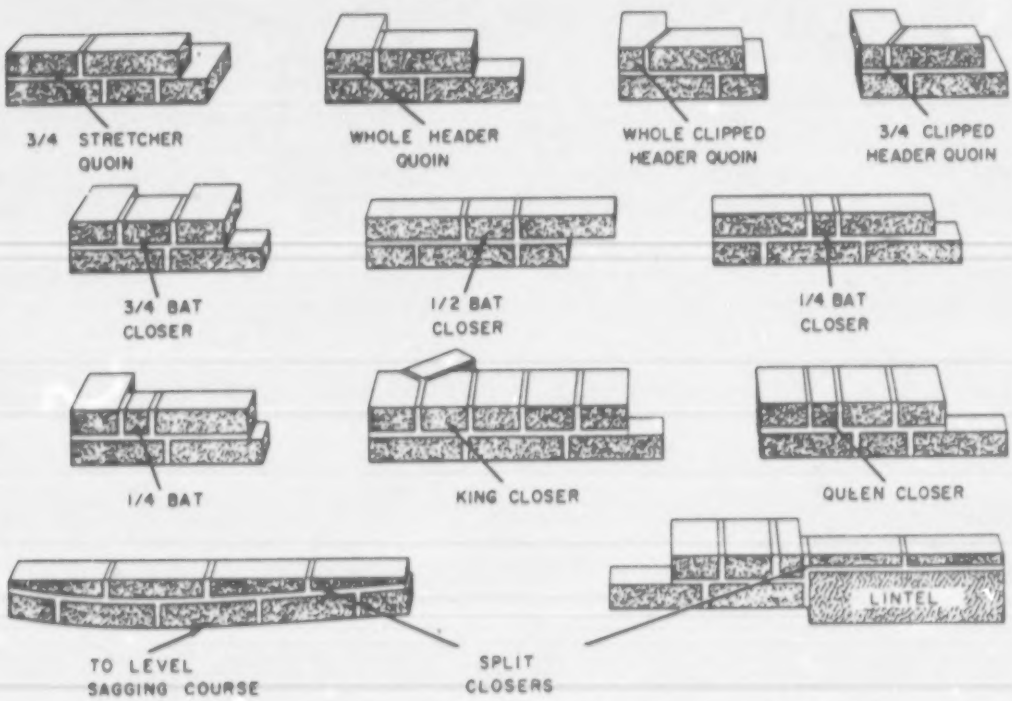


Figure 104. Use of Quoins, Bats, and Closers

Types of Bonds

STRETCHER. Stretcher bond is so called because the bricks in all of the courses are laid as stretchers. Figure 105 shows the stretcher bond.

HEADER. Header bond is so called because the bricks in all the courses are laid as headers. Figure 106 shows the header bond. Header bond can be used to advantage in curving walls.

COMMON OR AMERICAN. Common or American bond is probably the most used of any of the bonds. It is a combination of the stretcher and header bonds. It combines advantages of both bonds and is stronger than either one used alone. Usually, a header course is laid every sixth course, the other courses being stretcher courses. Brick masons, however, will sometimes vary the header course and lay it every fourth, fifth, or seventh course.

The common or American bond is used extensively in walls, particularly when common bricks are being used. The variation in this bond tends to help straighten the brickwork. It is the bond often used to back up face brick or other masonry materials used in the exterior tier of a wall. The header course of the bond is laid as shown in figure 105, and the stretcher courses are laid as shown in figure 106.

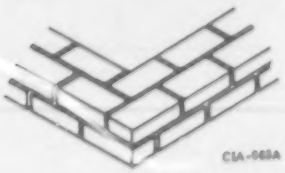


Figure 105. Stretcher Bond

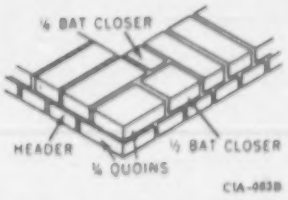


Figure 106. Header Bond

Preparing Mortar

Mortar is defined as "a combination of cement, sand, and water mixed in the correct proportions to produce a mix of workable consistency.

RECOMMENDED MIXES. The mortar commonly used for laying masonry units is made with masonry cement. If this cement is not available, you can use normal portland cement and hydrated lime mixed in the proper proportions. The recommended amount of materials proportioned by volume for mortar mixes is shown in figure 107. Mortar made with these mixtures will produce a strong bond between masonry units. Good mortar is necessary for good workmanship. Since mortar must bond masonry units into a strong, well-knit, watertight wall, it must contain a number of desirable properties. Let's examine some of them.

Desirable properties. One necessary property is workability. Mortar is said to be workable when it spreads easily and remains firmly in the mortar joints. A workable mortar will always adhere to masonry units. There is no need to add agents (lime, etc) to mortar made with masonry cement, because the cement itself produces the desired workability. The workability also depends partly on good mortar sand.

Mortar made with masonry cement also has good water retention, which prevents rapid loss of moisture when used with dry masonry units. It will also remain soft and plastic long enough for you to aline and level the masonry units. To avoid the rapid loss of water from suction, some masonry units must be moistened before they are used.

The use of entrained air will add to the workability and water retention of the mortar. Now let's discuss the other materials you will use to make a good mortar.

Materials. To make a good mortar, you must use sand that is free of dirt, vegetable matter, and salts. You can even produce a better mortar if the sand is uniformly graded and proportionately mixed.

There are several types of mortar sand, each having its own characteristics; so it would be difficult to specify the exact amount to use in preparing mortar. There should be enough particles of fine sand so that, when coated with cement paste, they fill to avoid the major voids between the coarser sand particles. An excessive number of fine sand particles requires more cement paste than a well-graded mixture.

Type of Service	Cement	Mortar sand in damp, loose condition	Hydrated lime
For ordinary service	1-masonry cement	2 to 3	-
	or		
	1-portland cement	4 to 6	1 to 1-1/4
Subject to heavy loads, violent winds, and severe frost action	1-masonry cement plus 1-portland cement	4 to 6	-
	or		
	1-portland cement	2 to 3	0 to 1/4

Figure 107. Recommended Mortar Mixes

In a well-balanced aggregate mixture, a certain percentage of the sand must pass through a sieve of a given size. The sieve numbers and the percentages of sand that should pass through the sieves are shown in figure 108.

The water used for making mortar should be as pure as drinking water. It should be free from chemicals, such as salts and alkalies. Large amounts of these chemicals or organic matter will affect hydration and the quality of mortar. To have the best possible mortar, the materials must be properly wetted and thoroughly mixed. The amount

Sieve Number	Percentage of Sand Passing Through Sieve
4	100
8	97
16	84
30	50
50	27
100	6

Figure 108. Graded Mortar Sand Mixes

of water is determined by wetness of the sand. Add just enough water to make the mixture plastic.

Mixing. Machine mixing should always be used except on jobs where the requirement for mortar is small. After the proper ingredients have been proportioned and placed in the mortar box or mixer, the quality of mortar will depend on the mixing time. You can improve the quality of hand-mixed mortar by mixing it for a long period of time. The same tools are used to mix mortar and concrete.

Remixing. Mortar that has stiffened on the mortar board should be retempered to regain its workability by remixing and adding more water. After mixing the mortar, you should use it within 2 to 2 1/2 hours if the temperature is 78°F, or higher. If the temperature is below 78°F, the mortar should be used within 3 1/2 hours. Any mortar you don't use within the time indicated should be disposed of.

Spreading Mortar

Bricklaying begins by distributing mortar on the foundation. This operation is called "spreading the mortar." To start the spreading stroke, bring the trowel of mortar to a horizontal position slightly ahead of where the depositing is to start. With a quick arm and wrist movement, turn the trowel toward the body to a vertical position. The mortar should slide off the trowel at an even rate and is deposited over the area with a uniform thickness and width. The throwing sequence is illustrated in figure 109.

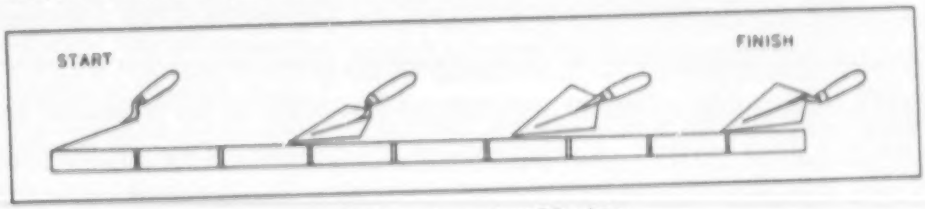


Figure 109. Throwing Mortar

Guttering Mortar

Guttering mortar consists of running the point of the trowel down the center of the mortar. This spreads the mortar. Work the mortar to just short of the edge of the brick or foundation. The guttering operation is shown in figure 110.

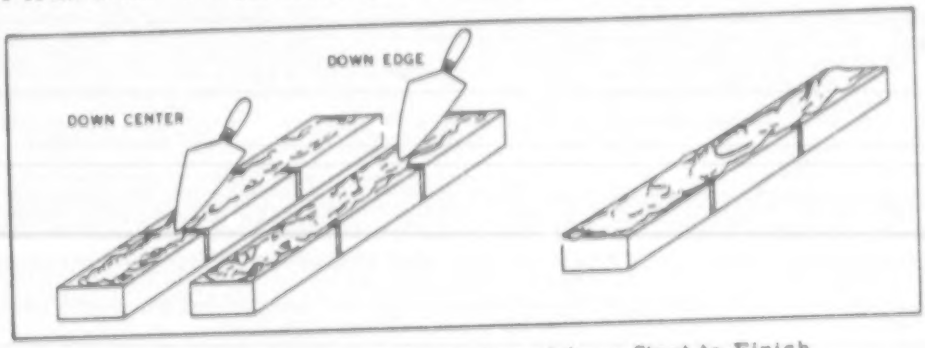
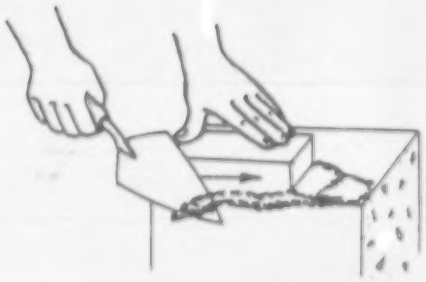


Figure 110. Mortar Being Guttered from Start to Finish

Cutting off Excess Mortar

Mortar that oozes out from under the brick should be cut off with the trowel in such a manner as not to pull out any additional mortar. The trowel should be flush with the outside brick surface, as shown in figure 111.



Cutting off Mortar

Buttering Brick

Butter the end of the brick with enough mortar to cover the brick end and to achieve the joint thickness specified in the building plans or job specifications. The joint thickness may range from 1/8 to 1/2 inch. Joints 1/4 to 3/8 inch thick are more common, however, since they provide greater strength and more water resistance.

Positioning the Corner Brick

Position the first brick slightly away from its final resting place. As the brick touches the mortar, press and shove it with a downward motion to as near its final resting place as possible. With the palm of the hand, press the brick down until mortar is squeezed out around the edges of the brick. (See figure 112.)

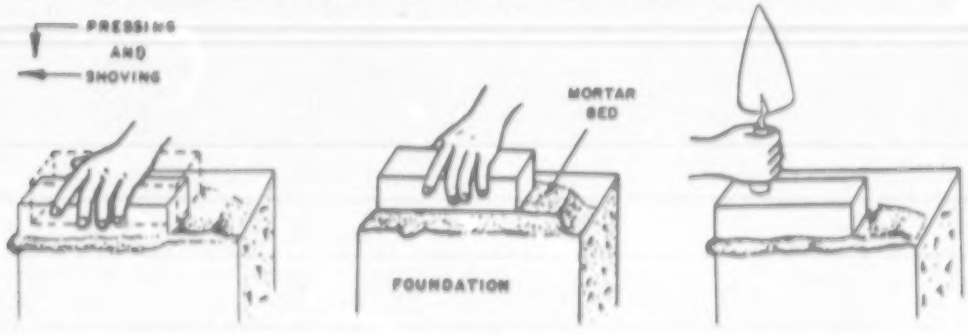


Figure 112. Laying the Corner Brick

The brick is exactly in its final resting place, thus further movement is unnecessary.

Tap

Tap the brick with trowel handle.

Laying Leader Bricks

Butter and position bricks 2, 3, and 4 on the line side, and 5, 6, and 7 on the return side in the same manner as the corner brick is laid. Maintain the same joint thickness while maintaining alignment with the chalk marks on the foundation. (See figure 113.)

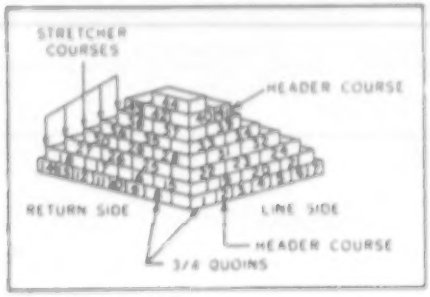


Figure 113. Arrangement of Bricks in Stretcher Bond Corner Lead

The second course is laid in reverse of the first course. That is, the first brick is laid lengthwise on the return side succeeded by bricks 9, 10, then 11, 12, 13 on the line side. The corner bricks are alternately installed lengthwise on the line side, then on the return side, until the first brick of the seventh course is laid. This procedure not only sets the bond pattern for the remaining stretchers but securely bonds the corners.

CORNERS AND INTERSECTIONS. A corner is formed when the ends of two walls meet, and it is here that the bond starts. Corners may be classed as being square, acute, or obtuse; or they may be classed as being outside or inside corners. A square corner is a 90° corner. An acute corner is one that is less than 90° and an obtuse corner is over 90° and less than 180°. Figure 114 shows the various types of corners.

Special arrangements for brick and special brick shapes are required to obtain the proper lap when starting a bond. The arrangement required in a 4-inch wall starting with the stretcher bond having one-half lap and three-quarter lap is shown in figure 115 The end brick should never be less than a brick wide.

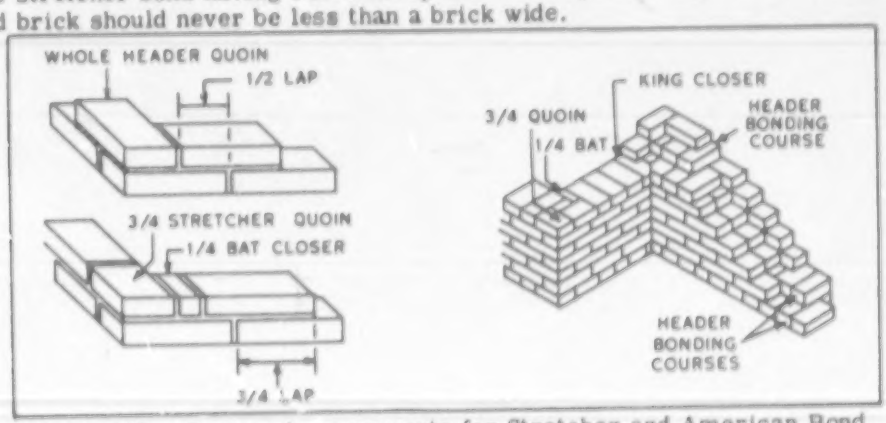


Figure 115. Corner Arrangements for Stretcher and American Bond

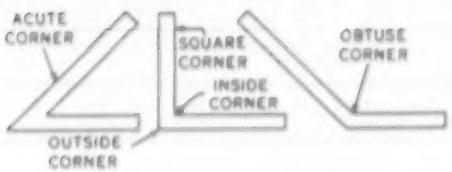


Figure 114. Types of Corners

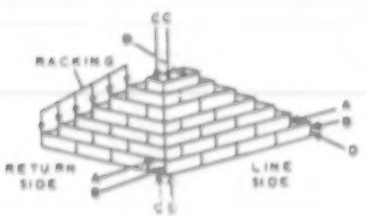


Figure 116. Aligning a Corner Lead

When arranging brick in a corner, you must take into consideration both walls. In some cases, the end of a wide wall may meet the end of a narrower wall to form a corner. Figure 115 shows the arrangements of standard and special bricks required in an 8-inch and 12-inch wall, meeting at a corner, to start an American bond corner.

Measuring Brick for Levelness

Each course must be leveled before the next course is installed. A bricklayer's level is placed near the outer edge and across the top of the brick from the corner to the edge of the lead, as indicated by arrow A in figure 116.

Straightedging Lead

The leads must also be aligned with the foundation, as well as with other bricks in the same course. A straightedge is placed along the vertical surface of the brick from the corner to the end of the lead, as shown in figure 116. Again, each course must be aligned before the next course is laid.

Plumbing the Corner

Arrow C in figure 116 indicates the line of plumbing for the corner. Tap the brick in or out as required.

Squaring the Corner

Squaring the corner is accomplished by setting a framing square to the outside surface of the brick.

Regardless of what adjustments must be made, they must be accomplished before the mortar sets. Otherwise, the bond between mortar and brick will not reestablish itself. Therefore, avoid laying more brick than what can be adjusted in the time span available.

Shaping Mortar Joints

After laying a few courses of brick, you should strike or finish the joints. To make flat or struck joints, use a brick trowel holding its face almost parallel to the face of the brick, pulling the trowel along the joint after you cut off the overhanging mortar. A flat or flush mortar joint is shown in figure 117.

Figure 117. Types of Mortar Joints

To form an inclined or weather-type joint (like that in figure 117), turn the trowel to a slight angle and strike the joint downward with the top edge of the blade. To form a raked joint, rake out a portion of the mortar in the joint with a flat jointer which is similar to those shown in figure 117. You can form a flush concave joint (like that in figure 117) by compressing the mortar in the joint with a convex jointer.

Mason Lines

LAYING THE STRETCHERS. Stretchers are the bricks which eventually form the wall. They are buttered, laid, and adjusted in the same manner as the corner leads are laid. Additional aids are employed to insure levelness and plumbness when the wall is a long one.

USING A LINE. Running a line from corner to corner identifies the top of the brick for the course being laid. (See figure 118.)

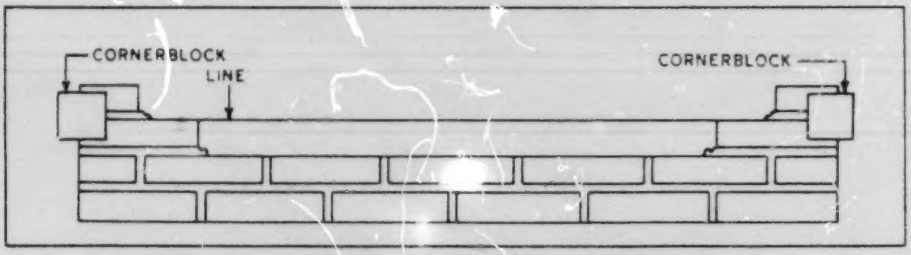


Figure 118

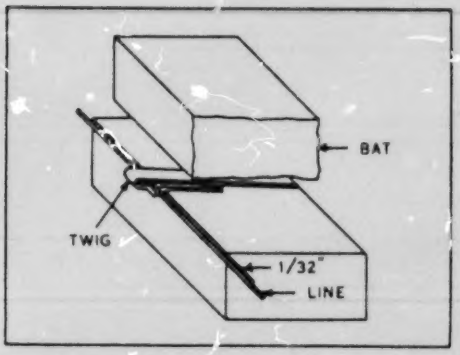


Figure 119. Intermediate Lead

The line should be fastened so that 1/32 inch exists between the line and the top outside edge of the bricks to be placed. The line must be tightly drawn to present a straight and level reference. If the wall is too long, then intermediate supports should be strategically placed to maintain line straightness (see figure 119).

Laying Bricks to A Line

USING A LINE. You should use a tightly drawn line, secured by line holders (pins, corner blocks, etc) to help you obtain a true wall surface. (Corner blocks used to secure the line are shown in figure 120.) Fasten the line so it is approximately 1/32 inch outside the top edge of the brick and level with it. Place bricks between corners without touching the line so that the line will not be shoved or crowded out of line each time a brick is laid.

A line stretched between leads is shown in figure 120. When the distance is long between corners, use an intermediate lead (twig) held in place by a brickbat to help support the line between corners. An intermediate lead is shown in figure 121.

To avoid disturbing the line, grasp the brick as shown in figure 122. The left view shows how the brick is grasped when you are standing outside the line and laying the brick across the line. The right view shows how the brick is grasped when you are standing inside the line.

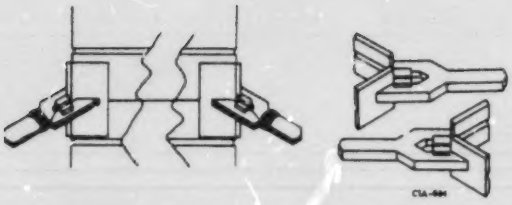


Figure 120. Corner Blocks

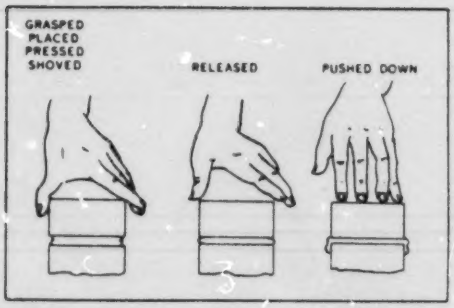


Figure 121. Laying Brick to the Line

LAYING THE REMAINING STRETCHER COURSES. Lay the remaining stretcher courses (two, three, four, five, and six) and level and straightedge the wall and strike and tool the joints as the work progresses. Before the mortar has set, touch up the joints and brush down the wall. Lay the brick in the backup course in the same manner as you laid the front course or face brick up through the sixth course. Lay the headers in the seventh course in the same manner as the headers in the first course. The corner bricks in the eighth course will aid in holding the corner blocks and line in place when you lay the seventh course.

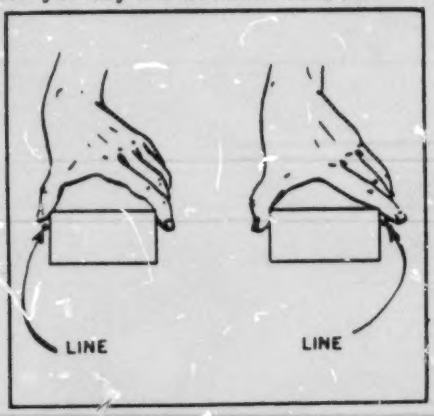


Figure 122. Setting Brick to Reference Line

Figure 122 illustrates the approximate position of the line to the brick being placed.

Another method of determining brick alignment is by sighting along the surface, using the corners as references. Brick that are out of alignment can be readily identified. Sighting across the top will enable dips or humps to be spotted. Naturally, using the sighting technique requires considerable practice to perfect the skill.

Anchor Bolts

Anchor bolts are often installed on 8-inch wall. Such bolts may be L-shaped or the common square-headed bolt. Normally, the bolt is installed at the header of four adjacent bricks. Unless the joint is extremely large, the corners of two of the bricks diagonal from each other must be trimmed to prevent the bolt shank from protruding through the joint. If an L-shaped bolt is installed, the bolt is turned so that one of the bricks lies over the short leg of the L.

Metal Ties

Metal ties are used to strengthen masonry by helping to fasten the several units in the wall together or to tie them to an adjacent structure. There are many shapes and sizes of metal rods, bars, and strips which are used as ties. Rod or bar stock 1/4 inch in diameter is commonly used for ties. A tie should be at least 2 inches long after it has been formed.

Metal ties should be covered with a coating of concrete grout (1 part cement and 2 parts fine sand). The action of lime in the mortar will destroy zinc coatings when the mortar is in direct contact with the ties. Mortar should be spread for the bed joint and the ties well embedded in the mortar. Generally, metal ties are laid 2 feet apart every sixth or seventh course.

Metal stock for "U," "Z," "O," corrugated, and other like ties should be bent at right angles so that the ends of the ties will run parallel with the masonry courses. The "Z" tie is probably the most used of the ties, although the "O" or rectangular tie is very good and is often used. The corrugated tie, made of metal strips, is best adapted for tying masonry veneer to wooden framework. These ties and several others are shown in figure 123.

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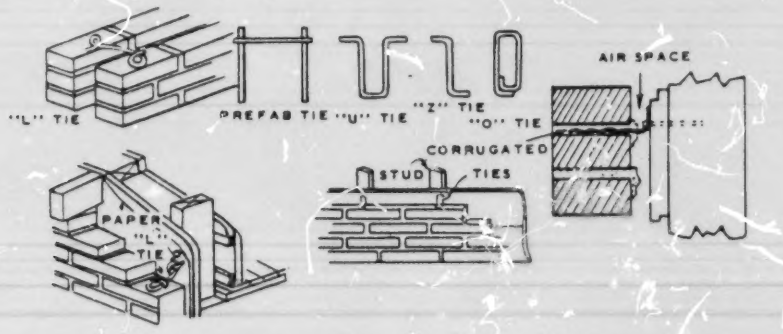


Figure 123. Types of Metal Ties

BONDING TECHNIQUES

Bonding techniques may differ, depending on the function, thickness and wall design. The wall discussed in the earlier part of this text consists of a single row of bricks laid horizontally. Brick may be laid vertically, on edge, and end facing out. Brick may be used to build walls 4 inches wide or more. No matter what the specifications are, the mason must determine the type of bonding technique he will use in the structure.

Bonding the brick quite simply means arranging the brick in such a way as to create the greatest strength for the structure. Once started the bonding technique should be applied throughout the whole structure.

Variations in bonding may be required when the structure has odd shapes or when making provisions for doors, windows or ornaments.

Figures 124 and 125 illustrate standard bonding and flashing around a window.

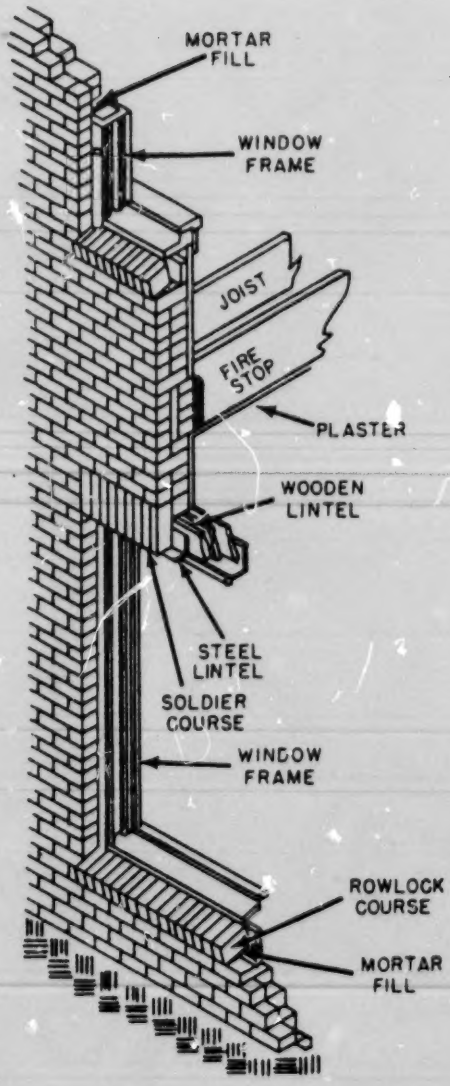


Figure 124. Soldier Course Above a Window Opening

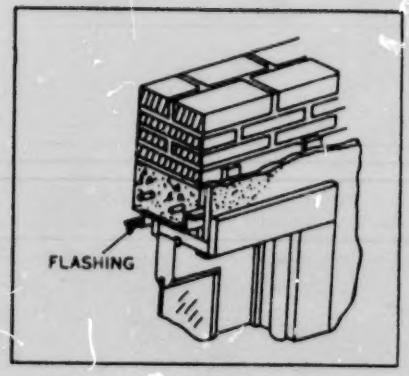


Figure 125

SUMMARY

Bricklaying is an art all by itself. Determining bond, laying corners, leveling, plumbing, spacing the stretchers all become critical when erecting a brick wall. Considerable practice is necessary to perform all these functions skillfully. Even after erecting the wall, the mason's job is not finished. Mortar and cement stains must be removed with muriatic acid.

QUESTIONS

1. What is a lead?
2. How is a corner located?
3. How do you gutter mortar?
4. What are the more common joint thicknesses.
5. What is buttering the brick?
6. How should corner leads be laid?
7. What is used to check the height of each course?
8. How are guidelines attached to corner brick?

9. What purpose does a line serve in bricklaying?

10. When are adjustments made in brickwork referring to alignment and plumbing?

REFERENCES

1. AFM 85-4, Maintenance and Construction Methods for Buildings and Structures

2. CDC 55253, Masonry Specialist

MAINTENANCE AND REPAIR OF MASONRY STRUCTURES

OBJECTIVE

Upon completion of this unit of instruction, you will be able to:

- inspect, clean, and repair joints and cracks in masonry walls.
- apply waterproofing and dampproofing materials to masonry structures.

INTRODUCTION

Planned preventive maintenance calls for crews of skilled individuals who can find defects and fix them. The job of the mason, on such a crew, is to inspect properly, install replacements, and make repairs on stone, concrete block, cinder block, brick, concrete, and other types of masonry walls, chimneys, foundations, walks, floors, and like structures. Also, to repair and replace defective tile, plaster, firebrick, cast material, fire clay, mortar, and other similar materials. Major repairs beyond the scope of preventive maintenance and defects involving skills other than masonry are reported to the proper supervisor or other designated authority within the organization.

REPAIR OF JOINTS AND CRACKS

Holes are forced through block walls by impact and are also created by the decay and disintegration of units within the wall. Broken, loose units and exposed mortar are removed from the damaged area in such a manner as to form a toothed or blocked hole. Figure 126 shows a hole in a block wall after it has been cleaned out and toothed.

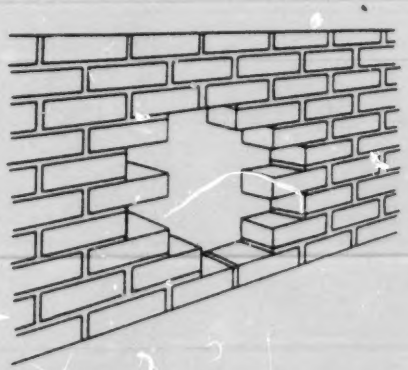


Figure 126. Cleaned out and Toothed Hole in Blockwork

Settled foundations are the cause of many cracks which occur in masonry walls. The settled wall should be forced back into position, and the defective portion of the foundation and wall rebuilt. Rebuilding, however, is not always feasible, and masonry units in the defective section of the wall are removed and the area rebuilt. Figure 127 shows a typical cracked condition in a block wall.

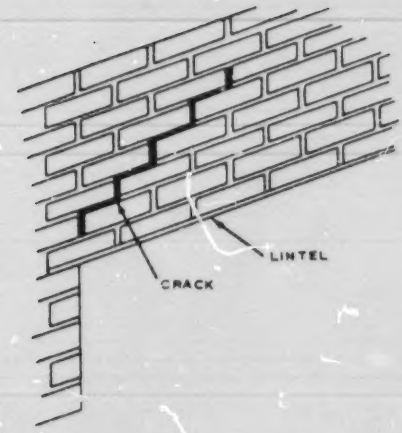


Figure 127. Typical Cracked Condition in Blockwork

METHODS OF REPAIRING CRACKS

Loose and broken masonry units and all exposed mortar are removed, and the hole is toothed or blocked to tie the newly laid blocks into the wall. A toothed hole resulting from the pattern of removal of bricks and mortar from the area of the crack is shown in figure 128.

Masonry units and mortar can be removed from the damaged area with a brick hammer, brick set, and other suitable chisels. Mortar is cleaned off masonry units in a wall first by cutting through the mortar with a beveled edge brick set, as shown in figure 129a, and second by tilting the set and driving it under the mortar, as shown in figure 129b.

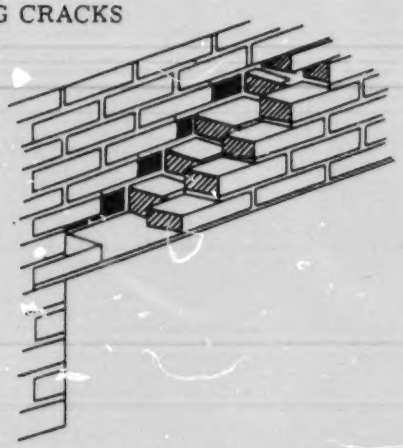
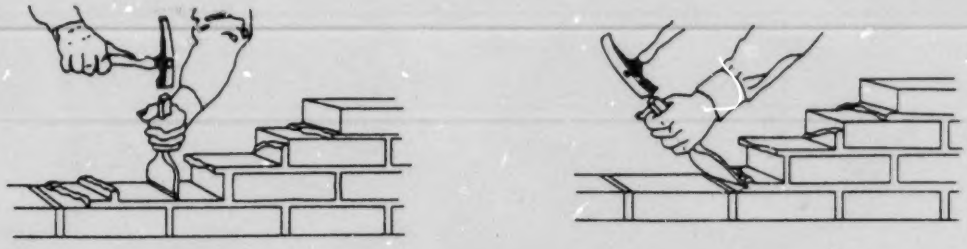


Figure 128. Cracked Area in Blockwork Cleaned and Toothed



a b

Figure 129. Cleaning off Mortar with a Brick Set

The old masonry units around the edges of the toothed hole and the new units are generally wetted before the masonry work starts. This, of course, will depend upon the types of units and mortar used, the weather conditions, as well as other factors which affect the rate of suction and the setting rate of the mortar. The backup units are laid in the hole first and the units in the facing tier are laid last. The mortar used in the fresh masonry should be protected against all adverse conditions in a convenient manner.

Small cracks and aging mortar between masonry units may be repointed to improve the watertightness of the mortar joints and the appearance of the block work. The old mortar is removed from the joints to a depth of 1/8 inch to 3/4 inch as required.

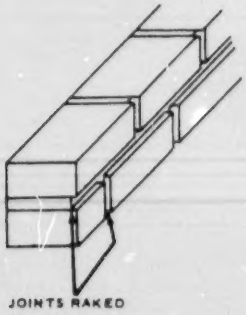


Figure 130. Mortar Joints Cleaned of Old Mortar

The old mortar is removed with hammers, thin chisels, rakes, and other tools required to do the job. A stiff brush or compressed air may be used to remove the dust and loose particles from the mortar joints. Figure 130 shows how mortar joints look after they have been chiseled out and raked to a uniform depth.

Fresh mortar is applied to the mortar joints by the tuck pointer with tools made for the purpose. Generally, bricklayer's trowels are used. The bricklayer's trowel and pointing trowel are used when the mortar joint is made flush with the face of the block. Figure 121 illustrates the procedure for repointing with a pointing trowel.

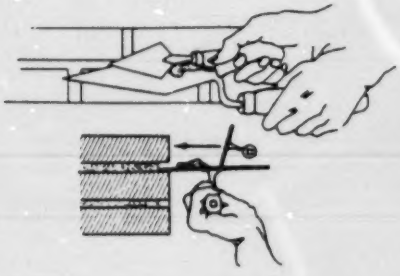


Figure 131. Repointing with a Pointing Trowel

Tuck pointing may be done with a cement mortar mix containing 1 part cement and 1-1/2 parts of fine sand. The dry ingredients should be mixed with water until the mortar is of puttylike consistency. Approximately 1/4 inch of mortar should be pushed off the hawk or large trowel into the mortar joint at one time. Mortar joints which are to be tooled are normally filled with a calking trowel and finished with a jointer of appropriate shape. The masonry should be brushed down and cleaned in a conventional manner.

Stone walls containing decayed or damaged stones are repaired by removing the defective units and replacing them with good stones. Or, instead of stones, the hole may be filled with concrete or brickwork similar to that shown in figure 132.

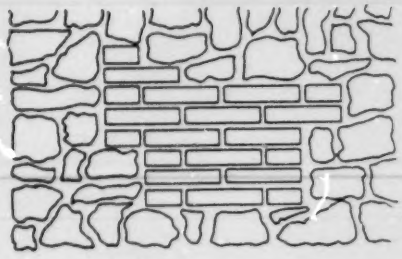


Figure 132. Stone Wall Repaired with Brick

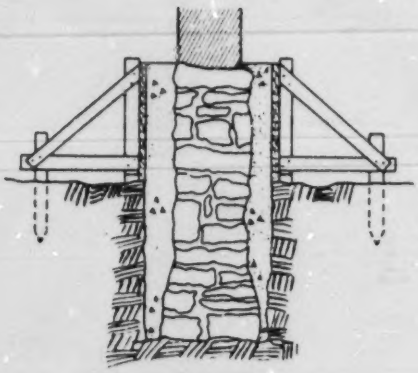


Figure 133. Strengthening a Stone Foundation

A faulty masonry foundation in which many of the stones are decayed should be replaced in whole or part with solid concrete. Great care, however, must be taken to support the stone foundation while the concrete foundation is constructed.

A stone foundation in fair condition may be strengthened with a thick concrete veneer placed over the stone faces. Defective stones are first removed from the foundation and the hole filled with concrete. Then, the concrete veneer is placed on each side of the foundation in the manner shown in figure 133.

CLEANING RESIDUE AND STAINS

Newly laid stone, particularly quarried stone, weathers and changes color slightly. It will, however, be changed to a similar uniform color of mellow tone. There will be none of the intense, unsightly blotchy stains. These stains are normally caused by mortar, fittings, or sources other than the stone itself (stone containing an oxide of iron may discolor somewhat).

Small cement stains on new stonework are sometimes left to bleach out under the actions of the elements. However, mortar and films of soot and dirt may be washed off the surfaces of the new stonework with soap putty. The putty is made by boiling strong laundry soap flakes in water until the mixture is of thick consistency. Three tablespoonfuls of household ammonia per gallon of water are mixed in , after the liquid soap has cooled. Enough white sand is then worked into the mixture to make a putty-like substance. The substance is used by working it into the stained surface of the stone, and scrubbing the treated surface with a stiff-bristled fiber brush. Then, the soap is washed from the surface with clean water.

Pronounced stains of various types may be removed from stonework (where white stone and white cement are not used) with a 10-percent muriatic acid-water solution. A 5-percent phosphoric acid-water solution or a 5-percent sulfuric acid-water solution should be used when the stone or the mortar is white. This avoids the slightly yellow discoloration which may result from the use of muriatic acid on these materials.

All stone surfaces treated with the acid solutions must be thoroughly washed with clean water to neutralize the acid and stop further chemical action. An additional precaution may be taken to neutralize acid solutions by washing the exposed surfaces with a 5-percent household ammonia-water solution . After the surfaces are neutralized with the solution, they must be flushed again with water to stop the chemical action. Protective clothing, such as goggles, rubber gloves, apron and boots, should be worn when cleaning with chemicals.

Concrete block and tile walls should be scrubbed with a stiff bristled brush. In some cases, it may be necessary to use a 10-percent muriatic acid-water solution and a stiff fiber-bristled brush to remove excess mortar and stains from the faces of some

masonry units. Surfaces treated with the acid should be flushed with water to stop further chemical action after the surfaces have been cleaned sufficiently. Acid on the masonry surfaces may be neutralized with a 5-percent solution of household ammonia and water.

CLEANING BRICK

Different types of brushes may be used for cleaning masonry and concrete surfaces. The surface finish, as well as the joints, should have sufficient time to set before cleaning. The type of brush used depends on the type of cleaning job to be done.

Muriatic acid may be applied to the brick surface, as well as cleaning solutions , with any of the brushes illustrated in figure 134. Long-handled brushes are best.

Using one of the steel brushes, heavy cement mortar deposits may be removed. Apply the brush to the surface with a scouring action. The brushes are also used in cleaning mortar joints when repairs are required.

In cleaning newly erected walls, care should be exercised not to remove any mortar from the joints.

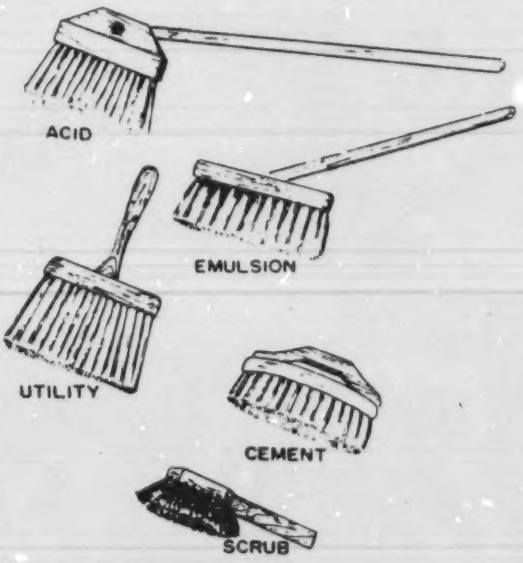


Figure 134. Types of Brushes

SEALING JOINTS

Old brick walls which have been weathered for a period of time may become cracked. It may be necessary to remove the old mortar and point up the joints.

First, remove the old mortar to a minimum depth of 1/8 inch with the small end of a brick hammer and chipping tool. A small or narrow chisel can also be used to remove the old mortar. The joint should then be cleaned with a stiff fiber brush to remove any loose particles.

Mortar may then be replaced and tooled to match the surrounding joints. It is a good practice to wet the joint prior to placing the mortar as this helps to form the bond. Importance is placed on the mortar adhering to the joint and that joint finished complements the surrounding joints.

Cleaning is the final operation in erecting a brick wall. Cleaning involves removing mortar cement and other materials that have stained the surface. Brushes, applied with vigor and aided by cleaning solutions, remove stains and other matter, and give the wall its final attractive appearance.

Removing cracked mortar is required before new mortar is applied. This not only eliminates the appearance of advanced stages of deterioration but seals the mortar joints and returns the wall to its original strength and beauty. Cleaning the repaired area is accomplished with the same tools and techniques used on new walls. In either case, cleaning should not take place until the mortar has set.

WATERPROOFING AND DAMPPROOFING

When concrete blocks and structural clay tile are used below ground level, they should be dampproofed or waterproofed no matter how well they are laid. There are several methods used to help eliminate the dampness problem.

Hot Tar Method

This is the simplest method, and it consists of applying hot tar or asphaltum to the outside surfaces below ground level. This method is preferred for mild conditions of dampness.

Membrane Method

This method is used where excessive dampness occurs and consists of applying hot tar or asphaltum with two or more layers of membrane (felt or roofing paper, for example). Figure 135 illustrates this method. Note that the joint where the wall attaches to the footing is filled with cement to form a slope, allowing the moisture to drain away from the footing.

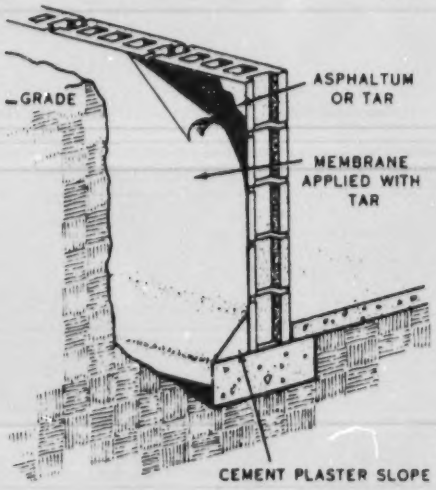


Figure 135. Waterproofing - Membrane Method

Tile Drain Method

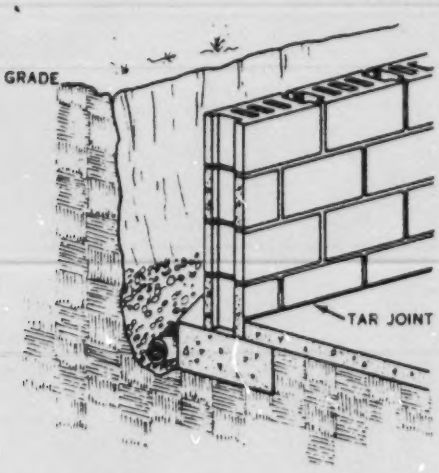


Figure 136. Waterproofing - Tile Drain Method

This method, as shown in figure 136 (to the left), is normally used where dampness is a big problem in high rainfall areas. The walls should also be treated as in the membrane method.

Clay or concrete tile are laid around all sides of the footing with a gravel or cinder fill covering it to the depth shown. The fill material allows the water to flow directly to the tile, where it collects and drains off to some point away from the wall where it can do no harm.

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Cement Plaster Method

Another method is used when soil conditions are such that excessive water is present. The method consists of applying a 1-inch-thick coat of cement plaster to the exterior surface, as shown in figure 137.

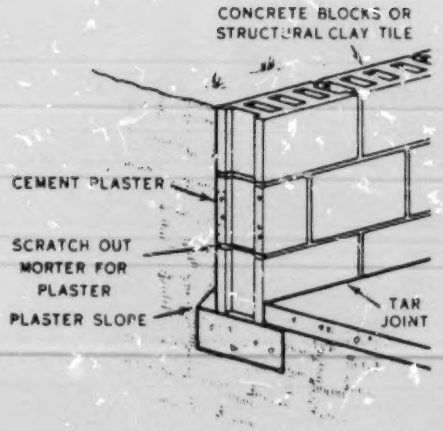

Figure 137. Waterproofing - Plaster Method

Any of these methods can be used separately or in conjunction with each other. The amount of rainfall, location of the wall, and soil conditions are the factors used to determine the method to use.

FORMING CONTROL JOINTS

Control joints are used to control cracking in masonry walls. Control joints are continuous vertical joints built into walls at points where these stresses might concentrate. To form a continuous vertical joint, full and half length blocks are used.

Control Joint Blocks

Control joints can also be formed with special control joint blocks. These blocks have tongue and groove shaped ends and are available in half and full length units. When half length units are not available, special carbide saw blades are used for cutting the block. The blades are installed in portable power saws. When cutting blocks with power saws, wear goggles to protect your eyes.

Sealing Control Joints

When control joints are exposed to the weather, seal them with an approved calking compound. When using calking compound, apply it with a calking gun having a tip slightly narrower than the joint, following the recommendations of the compound manufacturer. The compound is applied by inserting the tip of the gun in the joint, pulling the trigger, and moving it up and down along the joint until the joint is filled.

Calking compound can also be applied with a putty knife, although better results are obtained with a gun. Sometimes, oakum is used for sealing control joints. Oakum consists of strands of rope (loose fibers) pressed firmly in the joint and normally sealed with tar applied to the joint with a putty knife.

SUMMARY

The repair and reconditioning of masonry units can be prevented from becoming big expensive operations, accompanied by extensive shutdowns, through a scheduling program of preventive maintenance. Initially, good building construction resulting from correct and proper handling proportioning, mixing, placing, finishing, and laying of cementitious products and masonry units will do much to reduce the necessity for the

repair of concrete and masonry work later on. Defective building construction, as well as defective concrete and masonry materials themselves are responsible for a high requirement for repairing and reconditioning the materials.

QUESTIONS

1. What is used to clean concrete block masonry walls?
2. What is the recommended method of repair for a hole in a concrete block wall?
3. Name the tools used to remove the mortar from a damaged area.
4. What is the mixture normally used for tuck pointing?
5. Name two common alternate methods of repairing a stone wall, other than replacing the stone.
6. The minimum depth you must remove from a mortared joint is?
7. What is it necessary to remove mortar stains from brick work?
8. What is used to remove mortar from old joints that are to be repaired?
9. What is the final step in repairing a brick wall?
10. What tool is used to finish the joints to proper shape?

REFERENCES

1. AFM 85-4, Maintenance and Construction Methods for Building and Structures
2. CDC 55253, Masonry Specialist

ATC-SHEPPARD AFB TEX. 74-327

Technical Training

Masonry Specialist

LAYING CONCRETE BLOCKS, STONE, AND BRICK

December 1975

USAF SCHOOL OF APPLIED AEROSPACE SCIENCES
Department of Civil Engineering Training
Sheppard Air Force Base, Texas

Designed For ATC Course Use

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This supersedes WBs 3ABR55233-III-1-P1 thru -5-P2, September 1975
(Copies of the superseded publication may be used until the supply is exhausted.)

CUTTING MASONRY MATERIAL

OBJECTIVE

Working as a member of a four-man team and using a brick hammer, brick set, trowel, and masonry saw, cut and shape bricks, blocks, and stone as specified in the instructions provided. All bricks, blocks, and stone must be cut correctly.

EQUIPMENT

	Basis of Issue
SG 3ABR55233-III-1	1/Student
WB 3ABR55233-III-1-P1	1/Student
Masonry saw	1/12 Students
Brick hammer	1/Student
Brick set	1/Student
Brick trowel	1/Student
Brick, block, and stone	1/Student
Safety goggles	1/Student

Mission I

Using the Masonry Saw

You will use the masonry saw to cut the following masonry materials:

1. Brick - cut a 1/2 bat brick, a 3/4 bat brick, and a 1/2 soap (split) brick.
2. Blocks - cut a 3/4 block, a full cut header, and a beam or lentel.
3. Stone - cut and shape.

PROCEDURES

1. Safety precautions
   a. Remove all jewelry.
   b. Keep hands away from all moving parts.
   c. Keep the work area free from debris.
   d. Wear goggles while operating the saw.
2. Preoperational Check
   a. Check equipment for proper lubrication.
   b. Make sure the saw blade is tight.
   c. Check the water supply.

d. Make sure that all movable parts are free to move.

e. Check the electrical powerline.

3. Operational Procedures

a. Measure and mark the material to be cut.

b. Place the material on the saw.

c. Doublecheck the safety precautions - goggles, hands, and debris.

d. Turn on the water.

e. Start the motor.

f. Slowly move the blade into the material.

NOTE: The blade should cut at its own speed. With a little experience you will learn how fast to cut various materials.

g. After completing the cut, turn off the motor.

h. Stop the waterflow.

i. After the blade stops, remove and inspect the cut material.

j. Repeat the procedures until you have completed all of your required cuts.

Mission II

Brick Hammer

NOTE: Wear goggles while performing this project.

1. Procure a brick hammer and cut a 1/2 bat and a 3/4 bat.

NOTE: Hold the brick in your hand while cutting.

CAUTION: Direct the hammer so that the wasted pieces of the brick will be knocked away from your body.

2. Use a brick hammer and cut a 3/4 concrete block, and a concrete beam or lentel.

NOTE: The concrete block must be setting solidly on a base during the cutting.

3. Procure a stone and shape and square it for setting.

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Brick Set and Brick Trowel

NOTE: Wear goggles while performing this project.

1. Procure a hammer and a brick set and cut the following building materials.
   a. Brick - cut a 1/2 bat, a 3/4 bat, and a 1/2 soap (split) brick.
   b. Block - cut a 3/4 block and a 2 inch piece.
   c. Stone - shape and square.
2. Procure a brick trowel and repeat the procedures in step one.
3. Clean up the area.
4. Return all tools and equipment to the storage area.

107

ESTIMATING CONCRETE BLOCK CONSTRUCTION

OBJECTIVE

Given a sketch of a masonry project, estimate the number of concrete blocks and the amount of mortar required to complete the project. Estimations must be within -0% + 10%.

EQUIPMENT

	Basis of issue
SG 3ABR55233-III-2	1/student
WB 3ABR55233-III-2-P1	1/student
Pencil	1/student
Paper	1/student

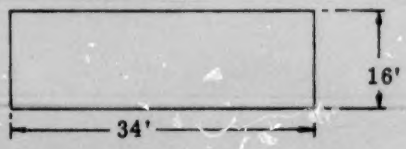
PROCEDURES

1. Use the following sketches and estimate the number of concrete blocks and the amount of masonry mix required for each project.

2. Write your answers in the blank spaces provided.

NOTE: It may be necessary for you to review the information on estimating in SG 3ABR55233-III-2 before completing this workbook.

1.



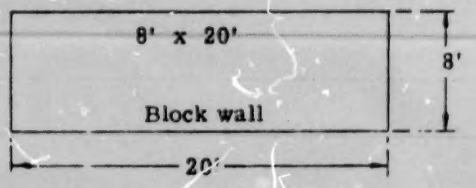
a. Number of blocks high _____

b. Number of blocks long _____

c. Total number of blocks _____

d. Amount of mortar required (give your answer in whole bags). _____

2.



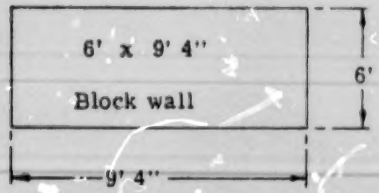
a. Number of blocks high _____

b. Number of blocks long _____

c. Total number of blocks _____

d. Amount of mortar required (give your answer in whole bags). _____

3.



a. Number of blocks high _____

b. Number of blocks long _____

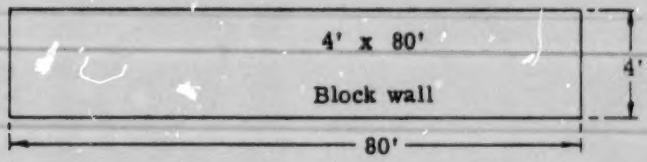
c. Total number of blocks _____

d. Amount of mortar required (give your answer in whole bags). _____

e. How many cubic feet of sand will be needed to mix this much mortar?

_____ cu ft.

4.



a. Number of blocks high _____

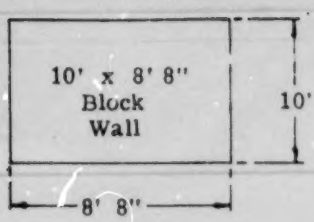
b. Number of blocks long _____

c. Total number of blocks _____

d. Amount of mortar needed (give your answer in whole bags). _____

e. How much sand will be needed to make this much mortar? _____ cu ft.

5.



a. Number of blocks high _____

b. Number of blocks long _____

c. Total number of blocks _____

d. Amount of mortar required (give your answer in whole bags). _____

e. How much sand will be needed to make this much mortar? _____ cu ft.

LAYING OUT A CONCRETE BLOCK WALL

OBJECTIVE

Working as a member of a four-man team and using specific tools, materials, and instructions provided, lay out a site for a one-story, concrete block, masonry structure. The site must be ready for the construction of the building.

EQUIPMENT

	Basis of issue
SG 3ABR55233-III-2	1/student
WB 3ABR55233-III-2-P2	1/student
50-foot steel tape	1/4 students
6-foot ruler	1/student
Pencil	1/student

Mission I

Story Pole

1. Procure a pencil, a ruler, and a piece of paper.
2. Draw a story pole on the paper for a concrete block wall 4-feet high.
3. Let 1/4 inch equal 1 inch.
4. Have the instructor check your work.

Mission II

Lay Out a Concrete Block Structure

NOTE: The instructor will divide the class into four-man teams.

1. Procure a 50-foot steel tape and 6-foot ruler.
2. Go to the assigned area.
3. Lay out a concrete block structure with the openings and dimensions shown in figure 1.

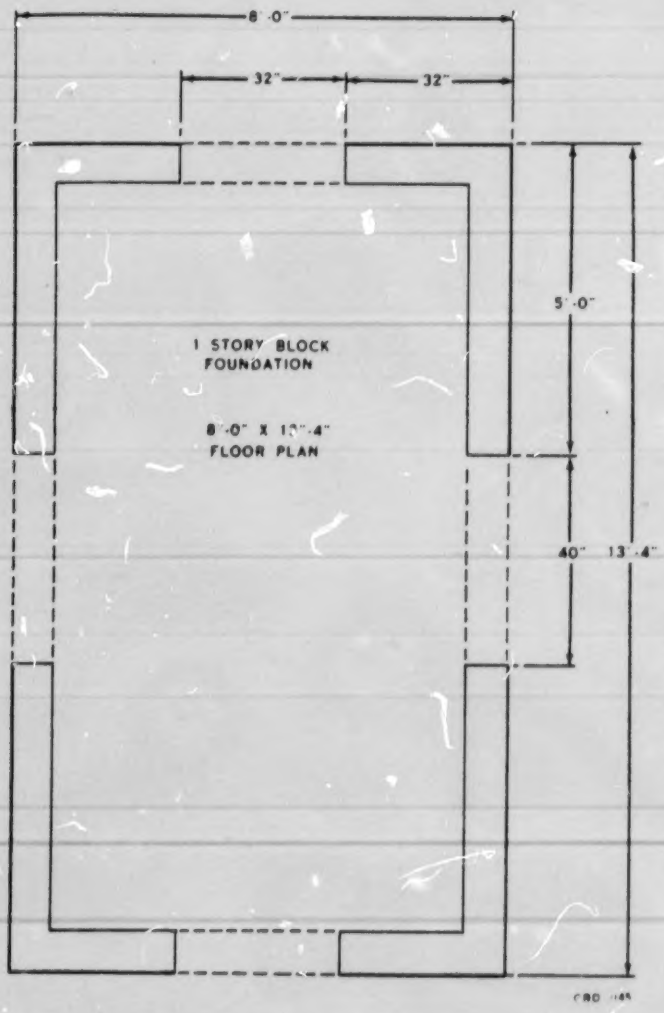


Figure 1. Concrete Block Structure

CONSTRUCTING A CONCRETE BLOCK WALL

OBJECTIVE

Working individually, but as a member of a two-man team, use concrete blocks and construct a corner for a one-story masonry building. The finished work must be within 1/4 inch of proper height and 1/4 inch of being plumb.

Working as a member of a two-man team, construct a block wall for a one-story masonry structure. The finished wall must be within 1/4 inch of proper height and 1/4 inch of being plumb.

EQUIPMENT

	Basis of Issue
SG 3ABR55233-III-2	1/student
WB 3ABR55233-III-2-P3	1/student
Concrete block	1/student
Mortar	1/student
Mixing box	1/12 students
Wheel barrow	1/6 students
Hoe	1/6 students
Shovel	1/6 students

Mission 1

Building A Concrete Block Corner

NOTE: Build the corner six courses high. (See figure 2.) Use 8-inch block and strike the joints on both sides.

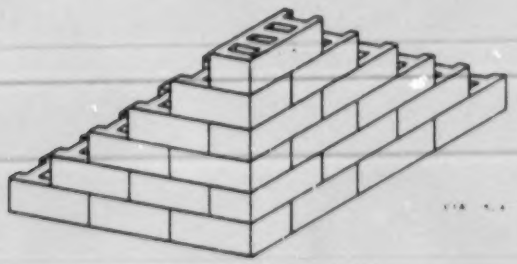


Figure 2. Corner Construction

The steps to follow when erecting a concrete block or structural tile wall are outlined below. Follow the step-by-step procedure as outlined. At any time any of the steps are not clearly understood, be sure to check with an instructor before proceeding.

Laying the First Corner

1. Lay out the bond.
2. Clean the foundation.
3. Lay out the corners and strike marks on the foundation.
4. Determine the units to be used in the first course. (Three blocks for each 4 feet)
5. Mix the mortar.
6. Spread mortar for the corner unit.

   NOTE: Be certain that the mortar is properly mixed before spreading.
7. Lay the first corner block. (Make certain that this block is in the same position as when the bond was laid out.)
8. Level the first corner block. (Test height)
9. Spread mortar for the second block.
10. Butter the end of the stretcher block.
11. Lay the stretcher block.
12. Level the stretcher.
13. Spread mortar for the second stretcher block.
14. Lay the stretcher block.
15. Level the lead.
16. Straightedge the lead.
17. Lay the other side of the first course.

18. Square the corner.

19. Spread mortar for the stretcher.

20. Butter and lay the stretcher.

21. Level the stretcher.

22. Test the height of the course

23. Strike the joints. (Ask the instructor as to the type, vertical or head joints first.)

24. Spread mortar for the second course.

25. Lay the corner block in the second course.

26. Level the corner block in the second course.

27. Plumb the corner block.

28. Adjust the corner block. (Test height.)

29. Lay the remaining stretchers.

30. Level the second course.

31. Plumb the second course.

32. Straightedge the second course.

33. Test height of the second course.

34. Strike the joints. (Again, ask the instructor as to the type.)

35. Plumb the corner.

36. Lay the third course.

37. Test the third course for levelness, squareness, plumb, height, etc., as the first two courses.

38. Adjust the third course as necessary.

39. Touch up all joints as necessary.

NOTE: Have the instructor check your work before proceeding.

Mission 2

Constructing a Block Wall

NOTE: The four corners of the building have been completed. The next step is to build the walls. If the four corners have been correctly constructed, building the walls is a simple matter.

Erecting the First Wall Section

1. Install the line. Have the line checked by your instructor before proceeding.
2. Fill in the first course stretchers.
   a. Spread the mortar.
   b. Butter the end of each stretcher block (as set).
   c. Set the stretcher block.
   d. Butter both ends of the closure block.
3. Testing and adjusting.
   a. Level
   b. Straightedge.
   c. Correct height.
   d. Adjust as necessary
4. Raise the line
5. Fill in the remaining course stretcher.
6. Test and adjust the third course stretchers.
7. Strike joints. (Again, ask the instructor as to the type.)

Have the instructor check the finished product.

Cleaning Tools and Area

The instructor will give the instructions about the wall construction, such as if it is to be left in position or if it is to be disassembled.

1. Clean all blocks and restack.
2. Clean handtools.
3. Oil tools which require oiling.
4. Place all tools in proper storage area.
5. Wash down the area around wall, or where wall was built.

ESTIMATING STONE CONSTRUCTION

OBJECTIVE

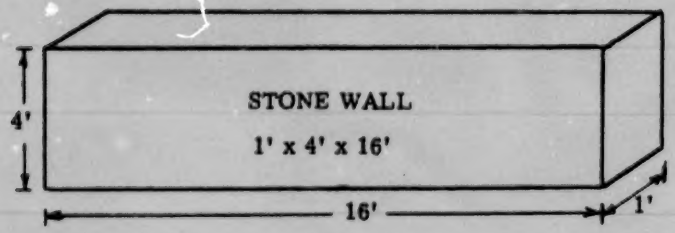
Given the construction drawing of a stone wall, estimate the amount of stone and mortar required to complete the project. Estimations must be within -0% + 10%.

EQUIPMENT

	Basis of Issue
SG 3ABR55233-III-3	1/student
WB 3ABR55233-III-3-P1	1/student

INSTRUCTIONS

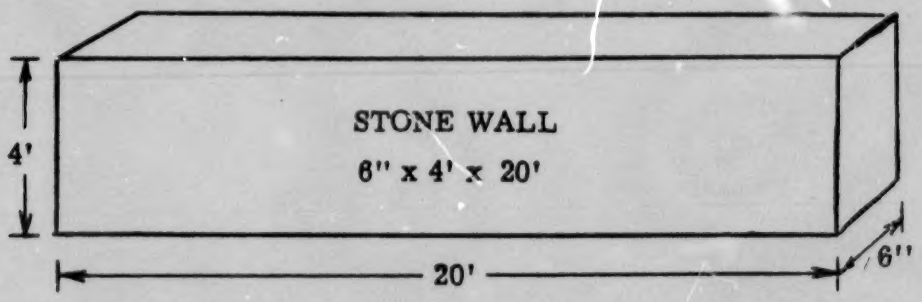
1. Study the following five sketches of masonry projects.
2. Estimate the number of cubic feet of stone required for each project.
3. Do your figuring on a piece of scrap paper.
4. Estimate the number of one sack mixes of mortar required for each sketch.
5. Write your answers in the space provided.



Sketch 1

a. Cubic feet of stone _____

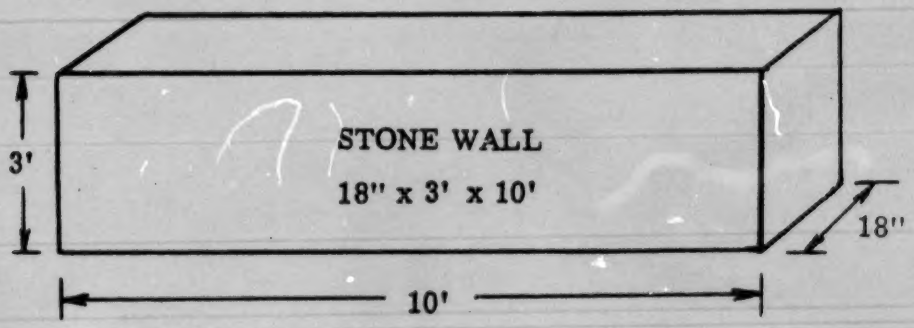
b. Number of one sack mixes _____



Sketch 2

a. Cubic feet of stone _____

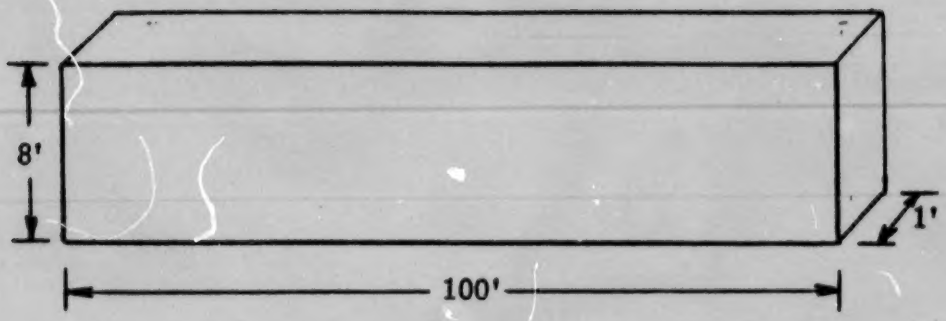
b. Number of one sack mixes _____



Sketch 3

a. Cubic feet of stone _____

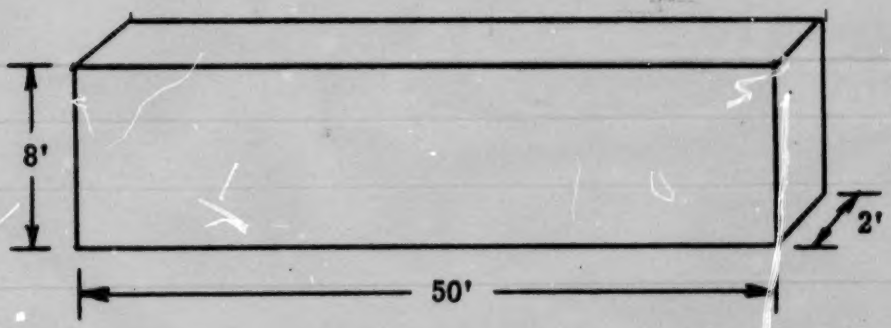
b. Number of one sack mixes _____



Sketch 4

a. Cubic feet of stone _____

b. Number of one sack mixes _____



Sketch 5

a. Cubic feet of stone _____

b. Number of one sack mixes _____

LAYING OUT A STONE WALL

OBJECTIVE:

Working as a member of a four-man team and using specific tools, materials, and instruction provided, lay out a site for a stone wall. The site must be ready for the construction of the wall.

EQUIPMENT

	Basic of Issue
SG 3ABR55233-III-3	1/student
WB 3ABR55233-III-3-P2	1/student
50-foot steel tape	1/4 students
6-foot ruler	1/4 students

PROCEDURES

1. Select the type stone to be used. Name the type stone selected.

   _____

2. Determine the bond to be used.

3. Prepare the foundation.

   a. Sweep the area.

   b. Wash the area with water if necessary.

4. Measure the area and determine the location of the corners.

5. Erect the corner post.

6. Measure and mark the location of the door and window opening.

7. Install the guide lines.

   NOTE: Double-check the location of the guide lines to make sure that they are accurate.

8. Place the mortar tables in position.

9. Stock the wall area with the selected stone.

CONSTRUCTING A STONE WALL

OBJECTIVE

Working individually, but as a member of a team and following instructions, construct a stone wall for a one-story masonry building. The completed wall must comply with good masonry practices and be within 1/2 inch of proper height and 1/4 of being plumb.

EQUIPMENT

	Basis of Issue
SG 3ABR55233-III-3	1/student
WB 3ABR55233-III-3-P3	1/student
Mason hand tools	1/student
Mixing box	1/12 students
Wheelbarrow	1/6 students
Hoe	1/6 students
Shovel	1/6 students

Laying Stone

NOTE: The steps to follow when erecting a stone wall of random rubble or quarry stone are outlined below. Follow the step-by-step procedures as outlined. At any time any of the steps are not clearly understood, be sure to check with an instructor before proceeding

1. Lay out the area of the wall.

2. Select the stone to be used.

3. Lay out the bond.

4. Clean the foundation.

5. Mix the mortar.

6. Prepare the mortar bed (2 inches thick).

7. Postion the corner stone. (Make certain that the stone is positioned the same way as when the bond was laid out).

8. Prepare the mortar bed and position the bottom row of stones.

9. Fill the head joints with mortar and small stones.

10. Align the stone by the use of a level and guide line.

11. Position the remaining stones and mortar to provide uniformity and appearance. Keep the wall straight and plumb at all times, using the same method used when laying blocks.

12. Position the rock bolts in the top course.

13. The instructor will given you instructions as to whether the wall is to be left in position or disassembled.

14. Clean all the stones and restack.

15. Clean the hand tools.

16. Oil all the tools which require oiling

17. Place all the tools in their proper storage area.

18. Wash down the area around the wall, or where the wall was built.

ESTIMATING BRICK CONSTRUCTION

OBJECTIVE

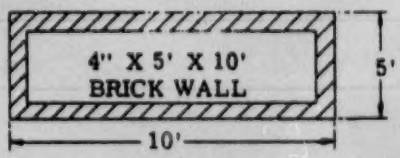
Using a construction drawing of a masonry project, determine the number of bricks and the amount of mortar required to complete the project. Estimation must be within -0% + 10%.

EQUIPMENT	BASIC OF ISSUE
SG 3ABR55233-III-4	1/student
WB 3ABR55233-III-4-P1	1/student
Pencil	1/student
Paper	1/student

PROCEDURE

1. Procure pencil and paper.
2. Study each of the following drawings.
3. Determine the information required. Make your calculations on scrap paper.
4. Write your answers in the spaces provided.

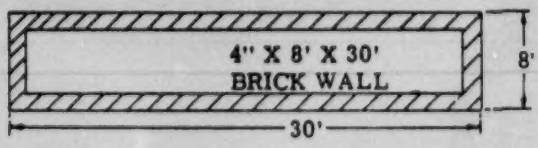
1.



a. Total number of bricks _____

b. Whole bag mixes _____

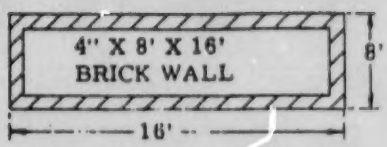
2.



a. Total number of bricks _____

b. Whole bag mixes _____

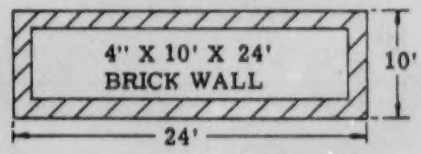
3.



a. Total number of brick _____

b. Whole bag mixes _____

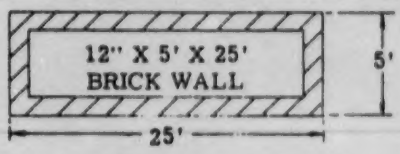
4.



a. Total number of brick _____

b. Cubic feet of sand _____

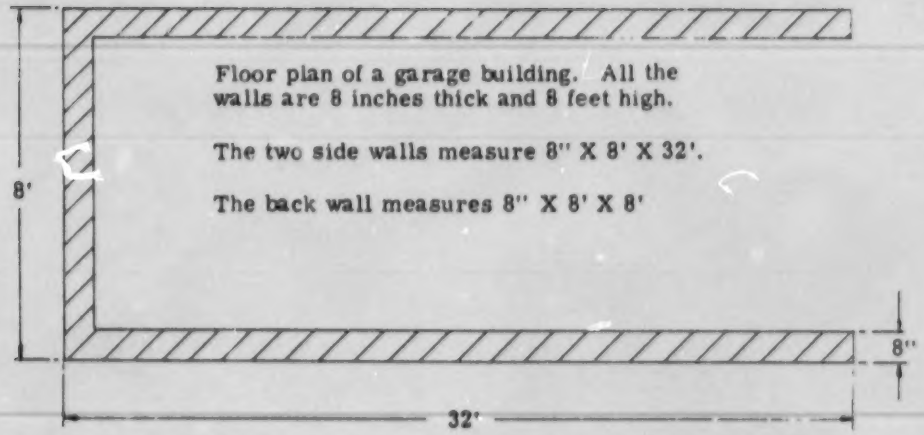
5.



a. Total number of brick _____

b. Whole bag mixes _____

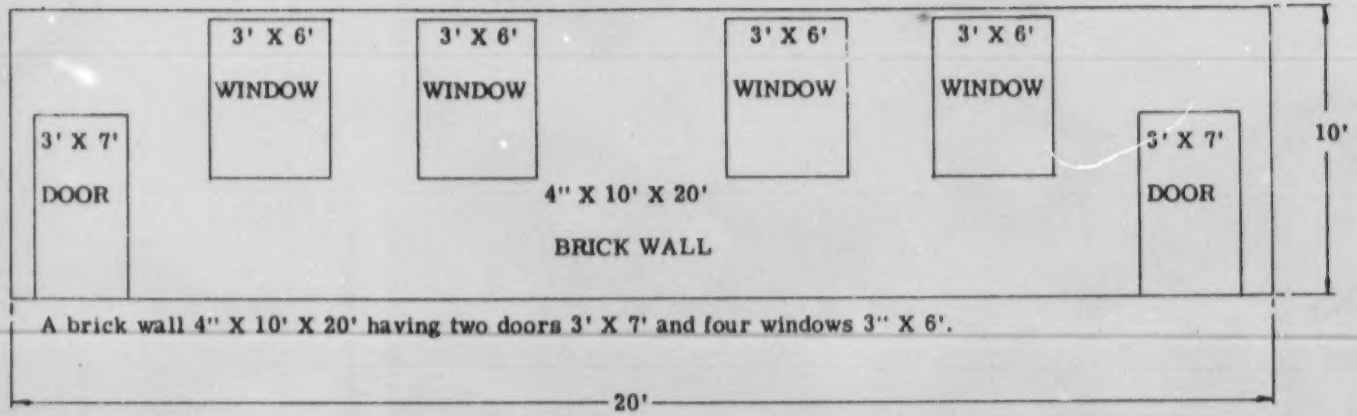
6.


Floor plan of a garage building. All the walls are 8 inches thick and 8 feet high.
The two side walls measure 8" X 8' X 32'.
The back wall measures 8" X 8' X 8'
8'
8"
32'

a. Total number of brick _____

b. Whole bag mixes _____

7.



A brick wall 4" X 10' X 20' having two doors 3' X 7' and four windows 3" X 6'.

a. a. Total number of brick in wall without the doors and windows _____.

b. Number of brick needed to brick in the doors and windows _____.

c. Total number of brick for the wall 4" X 10' X 20' having two doors 3' X 7' and four windows 3' X 6' _____

_____.

LAYING OUT A BRICK WALL

OBJECTIVE

Working as a member of a four-man team, and following given directions, lay out the site for a one-story brick building. Indicate the location and size of the window and door openings. All measurements must be with ± 1/4 inch of given specifications.

EQUIPMENT

	Basis of Issue
SG 3ABR55233-III-4	1/student
WB 3ABR55233-III-4-P2	1/student
50-foot steel tape	1/student
6-foot ruler	1/student
Pencils	1/student

Mission 1

Lay Out a Brick Wall

1. Procure the tools you will need to lay out a brick wall. Name the tools required.

_____

_____

_____

2. Go to the area assigned by the instructor.

3. Select the type of brick to be used. The brick selected is

_____.

4. Determine the type of bond to be used.

5. Prepare the foundation.

   a. Sweep the area.

   b. Wash the area with water, if necessary.

6. Measure and mark the corner locations.
7. Take diagonal measurements to insure that the foundation is square.
8. Measure and mark the window and door openings (see figure 3.).
9. Chase the bond around the complete foundation.
10. Adjust the head joint to work out an even number of whole or half bricks.
11. Position the mortar tables.
12. Stock the work area with brick.

Mission II

Prepare a Story Pole

1. Select a straight 1x4-inch board.
2. Cut the selected board 48-inches long.
3. Select a course counter ruler with a #6 joint measurement.
4. Lay out the stretcher courses. NOTE: Use the American Bond.
5. Lay out 7th course headers for American Bond.
6. Place an arrow to indicate the top of the story pole.
7. Keep this story pole; you will need it later.

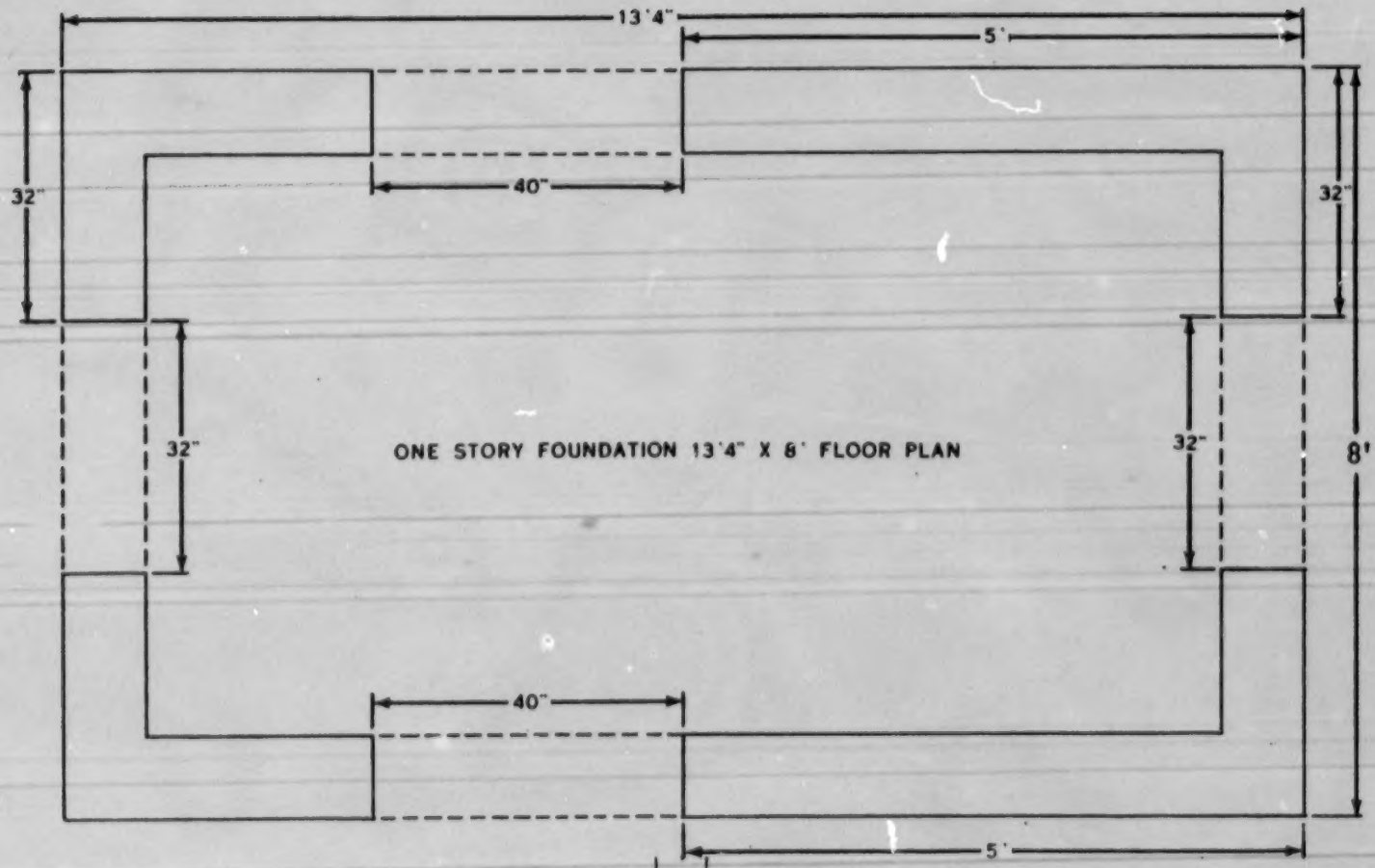


Figure 3. Foundation Plan

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CONSTRUCTING A BRICK WALL

OBJECTIVE

Working individually, but as a member of a four-man team, use brick and construct a corner for a one-story masonry building. The finished work must be within 1/4 inch of proper height and 1/4 inch of being plumb.

Working individually, but as a member of a team, construct a brick wall for a one-story, masonry structure. The finished wall must be within 1/4 inch of proper height and 1/4 inch of being plumb.

EQUIPMENT

	Basis of Issue
SG 3ABR55233-III-4	1/student
WB 3ABR55233-III-4-P3	1/student
Mixing box	1/12 students
Wheelbarrow	1/16 students
Brick	
Mortar	

STEPS TO BE FOLLOWED IN BRICK CONSTRUCTION

1. Locate the position of the corner brick.
2. Close out the bond.
3. Mix lime cement mortar. (This type mix will permit the wall to be easily dismantled later.)
4. Spread and gutter the mortar for the corner leads.
5. Position the corner brick. (See figure 4.)
6. Butter the head joints and lay the leads in the first course.
7. Space, level, and align the first course.
8. Repeat steps 4 through 7 for the remaining courses in the lead corner.
9. Check the bricks for plumb, straightness, levelness, and uniform spacing.

10. Check the corner for squareness.

11. Lay the remaining stretchers in the wall as per steps 6 and 7. (See figure 5.)

12. Strike the joints.

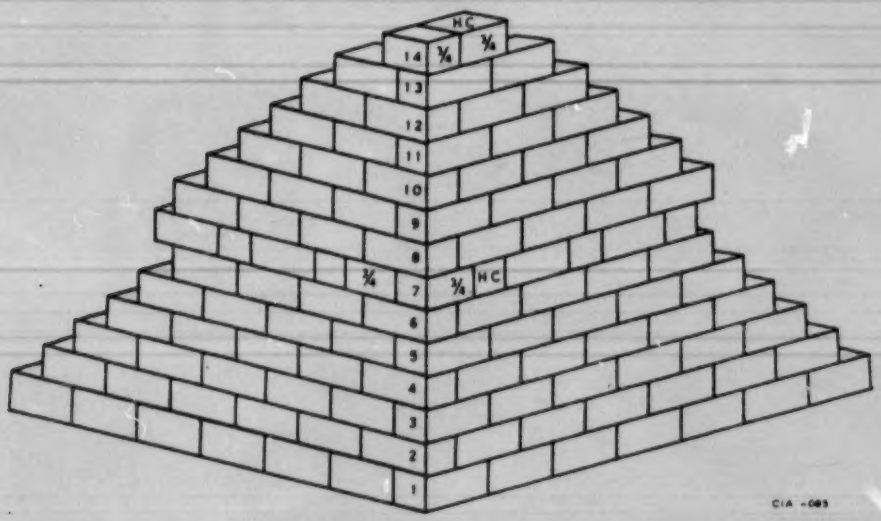
13. Remove the excessive mortar from the brick face. DO NOT REMOVE THE MORTAR FROM THE JOINTS.

14. Dismantel the brick wall using appropriate tools.

15. Using mason's hammer, brick set, or trowel, remove mortar from brick.

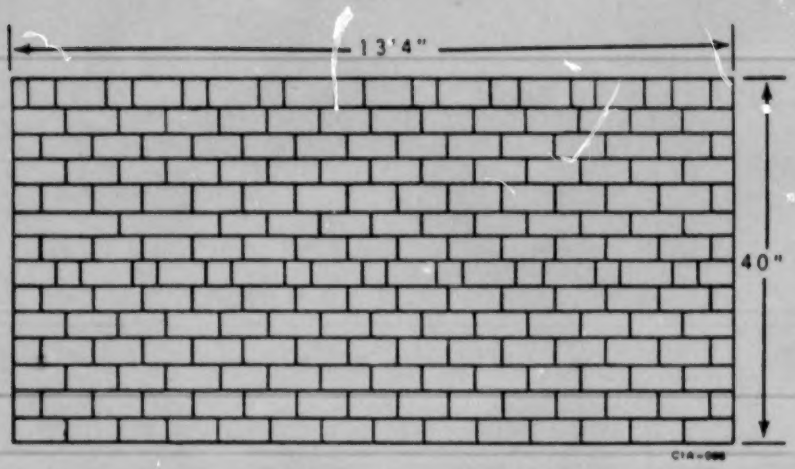
16. Stack the bricks.

17. Clean and store the tools.



DOUBLE BRICK WALL CONSTRUCTION USING AMERICAN WITH THE JOINTS STRUCK ON THE FACE SIDE. THE HEADER COURSE IS ON THE 7TH LAYER.

Figure 4. Completed Brick Corner



DOUBLE BRICK WALL CONSTRUCTION USING AMERICAN BOND WITH THE JOINTS STRUCK ON THE FACE SIDE. THE HEADER COURSE IS ON THE 7TH LAYER.

Figure 5. Completed Brick Wall

INSPECTING, CLEANING, AND REPAIRING MASONRY SURFACES

OBJECTIVE

Following given directions, inspect, clean, and repair joints and cracks in a masonry wall. All joints must be repaired correctly.

EQUIPMENT

	Basis of Issue
SG 3ABR55233-III-5	1/student
WB 3ABR55233-III-5-P1	1/student
Wheelbarrow	1/6 students
Hoe	1/6 students
Shovel	1/6 students
Sand	
Mortar	

PROCEDURES

1. Inspect the damaged wall.

   a. What caused this damage? _____

   b. What is the best method of repair? _____

   _____

2. Use a hammer and chisel to remove the old mortar from the damaged area.

3. Mix mortar to match the existing wall.

4. Wet the block or stone. What is the purpose of this step?

   _____

5. Replace the mortar using a point and brick trowel.

6. Finish the joint to appear uniform with the surrounding joints.

7. After the mortar has had time to set, brush the excess mortar from the face of the bricks.

8. Clean and place the tools in their proper storage area.

NOTE: The instructor will provide necessary instructions concerning the finished project. Some walls will be left standing and others will be disassembled and block or bricks cleaned and stacked in the storage area.

APPLYING WATERPROOFING AND DAMPPROOFING MATERIALS

OBJECTIVE

Following given directions, apply waterproofing and dampproofing materials to masonry structures. The surface must be completely covered with no visible voids.

EQUIPMENT

	Basis of Issue
SG 3ABR55233-III-5	1/student
WB 3ABR55233-III-5-P2	1/student
Brush	1/2 students
Waterproofing materials	

PROCEDURE

1. Inspect the area to be waterproofed.
2. Where would you normally expect to find waterproofing materials applied? _____
3. Clean the area to be treated.
4. Prepare the dampproofing material.
5. Brush or roll-on the dampproofing materials.
6. Check the completed work.
   NOTE: To be effective the complete surface must be covered with no voids.
7. Waterproofing materials are very difficult to remove from hands and clothing. Therefore, you should wear protective clothing and gloves when applying this material.

20 137

Department of Civil Engineering Training

Masonry Specialist

PLASTER, STUCCO, AND TILE

August 1973

SHEPPARD AIR FORCE BASE

Designed For ATC Course Use

DO NOT USE ON THE JOB

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This supersedes Study Guides 3ABR55233-IV-1, 15 March 1972, and 3ABR55233-IV-2, 9 March 1972.

APPLYING PLASTER AND STUCCO

OBJECTIVE

Upon completion of this unit of instruction, you will be able to:

- lay out a lath surface for plaster or stucco.
- mix and apply a scratch coat of plaster.
- mix and apply a brown coat of plaster.
- mix and apply stucco to a prepared surface.
- inspect and repair damaged plastered surfaces.

INTRODUCTION

Plaster is a facing material that is applied to walls and ceilings. When plaster is used on exterior walls, it is called stucco. Plastering is one of the most ancient trades. Primitive man built frame works of sticks and then plastered them with mud. Plaster, a more lasting material, later replaced the mud. The tools used by the early plasters resemble very closely those used by the tradesman of today.

This study guide will discuss plastering and stuccoing under the following topics.

- MATERIALS AND TOOLS
- APPLICATION PROCEDURES
- CAUSES OF PLASTER DAMAGE
- REPAIR PROCEDURES

MATERIALS AND TOOLS

Plaster as a Building Material

Plaster is primarily used for finishing facing surfaces. It is applied to specially prepared bases. Early Egyptians and Greeks used lime, sand, a gypsum mix, and water as a mud in coating their structures. This particular composition had a serious drawback in that it required several days, sometimes as long as 2 weeks, for one coat to set. Plaster of paris and gypsum were later used, due to their reduced setting time.

Plaster is composed of several ingredients: water, aggregate (or lightweight aggregate), a cementing agent or binder, and sometimes admixtures.

Plaster is applied in three coats: (1) the scratch coat; (2) the brown coat; and (3) the finish coat. Each coat must be properly leveled and allowed to set before the next coat is applied. If portland cement is used, each coat will have to be moist-cured before the next coat is applied. The scratch and brown coat must be moist-cured 2 days each and allowed to dry 5 days each, before applying the next coat. Before each coat is applied, the previous coat must be dampened to prevent the moisture from being absorbed from the fresh plaster too fast.

When finished, plaster presents a seamless, smooth surface which may be painted or papered.

Plaster Bases

There are several bases to which plaster can be applied. Wood, metal, gypsum board, and masonry are the most commonly used boards.

WOOD LATH. Wood laths are thin strips of wood lathes approximately 1-1/2 inches wide with rough surfaces. The laths are installed on the studding, using 3/8-inch spacing with every seventh row staggered, as shown in figure 1. Leave a space of 1/4 inch between the ends of the laths. Wooden laths must be dampened before plaster is applied, to prevent the wood from drawing the moisture from the plaster.

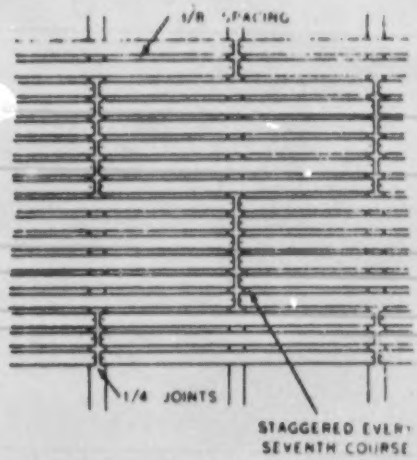
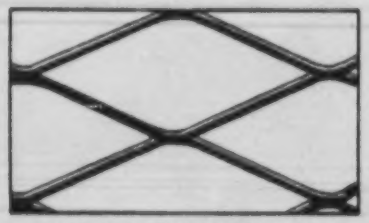
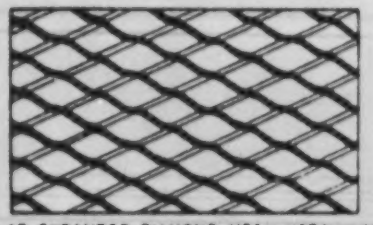


Figure 1

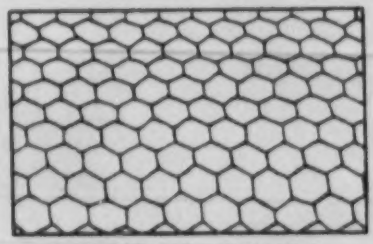
METAL LATH. Metal lath is available in several configurations, as shown in figure 2 below.



EXPANDED STUCCO MESH LATH



FLAT EXPANDED DIAMOND MESH METAL LATH



HEXAGONAL WIRE MESH LATH

Figure 2

2

The diamond-shaped metal lath has openings of 5/16 x 9/16 inch. It is used on interior walls and ceilings. Metal lath should be coated with a rust-inhibitive paint or galvanized to prevent rusting.

Metal wire mesh for stucco is attached to exterior surfaces with special furring nails as shown in figure 3. These nails, after building paper or felt has been applied over the surface, hold the mesh in place. The mesh should stand away from the surface at least 1/4 inch.

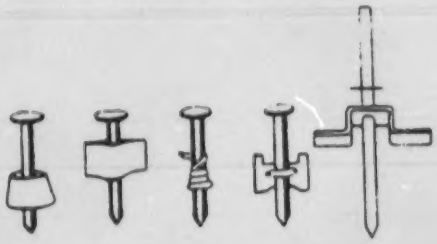


Figure 3. Types of Furring Nails

Both the interior and exterior diamond metal lath have a correct and incorrect installation posture. The long side of the diamond must be horizontal. There are small cups formed at each intersection of the diamond walls. These cups must be pointed up so that plaster will flow down behind the mesh and form a lock. The plaster tends to flow off the mesh if the cups are pointed down.

GYPSUM BOARD LATH. Gypsum board lath is the most popular base in use today. It has greater advantages for installation, insulation, fireproofing, and plaster bonding for smoother surfaces than any other lath. It is available in plain or perforated surfaces, 1/2 or 1 inch thick, 16, 18 or 24 inches wide, and 48 inches long. It should not be premoistened. Standard gypsum cement plaster or gypsum wood fiber plaster containing no lime should be used for the first two coats of plaster. A standard finish coat may be used over the brown coat.

MASONRY. When plaster is applied to masonry surface, it is essential that a good bond be achieved. If the masonry surface has a rough finish, it is said to have a good mechanical bond. If the surface is dense and smooth, it will have to be roughened. A brick hammer may be used to scratch and chip the surface. The marks or chips should be uniformly spread over at least 70% of the area.

A second method of achieving a rough surface is to use a machine specially designed for that purpose.

A third method is to apply a dashbond coat. This consists of 1 part portland cement and 1 to 2 parts sand with enough water to give the mixture an adhesive consistency. It is splattered on the surface with a stiff brush. Allow the material to harden undisturbed.

Suction is another factor in determining how well plaster will stick to the surface. Spray the surface with water and observe the reaction. If all of the water is not drawn into the surface, then it will be impossible to obtain a good bond. Lath will have to be installed over the masonry surface to provide a good base for the plaster.

Weathered masonry surfaces may absorb the water too rapidly. This causes plaster to stiffen too rapidly and it becomes difficult to work. Spray the surface with several applications of water; do not soak. Take care in spraying the entire surface with like amounts of water. Some parts of the surface will draw more water than others and will result in spotted surfaces.

Tools Used in the Application of Plaster and Stucco

Plaster, as well as any other mortar material, must be thoroughly mixed and to the correct consistency if an attractive and durable finish is to be achieved. Ready-mix plaster needs only water be added to prepare the plaster for application. Job mixing, however, requires large amounts of plaster to be mixed. Job mixing requires each ingredient to be mixed in proper proportions and quantity to satisfy the job requirement. Mixing is accomplished by using a power mixer and mixing the dry ingredients for 5 minutes before adding water.

HAWKS. A portable platform, called a plaster's hawk, is used to hold a small supply of plaster. The hawk, shown in figure 4, is held near the base surface, so the plaster can be pushed onto the base surface.

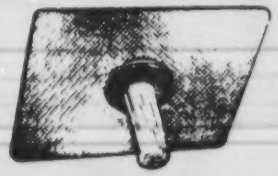


Figure 4. Hawk

TROWELS. A variety of trowels, as shown in figure 5, are used to transfer the plaster from the hawk to the base surface.

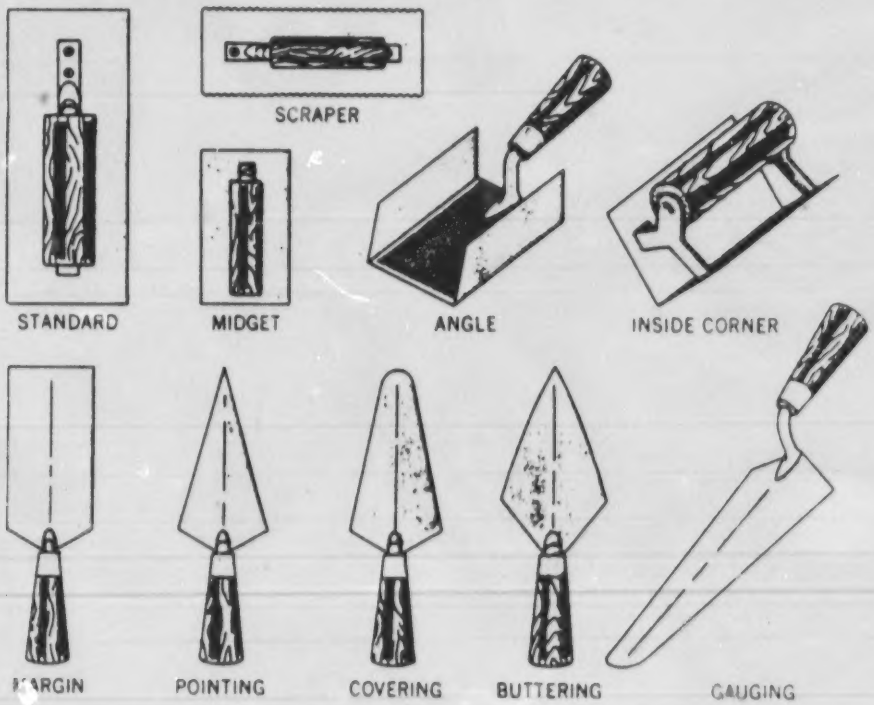


Figure 5. Trowel

FLOATS. A variety of floats are available for finishing plaster. A smooth-bottomed float is used for creating a smooth finish, while carpet- or rubber-bottomed float is used to produce a textured finish. Three types of floats are shown in figure 6.

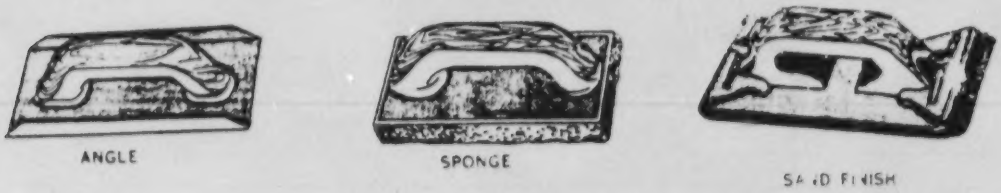


Figure 6. Three Types of Floats

SCARIFIERS. A scarifier, shown in figure 7, is used to roughen the plastered surface so that the next coat of plaster will have something to cling to. The scarifier consists of a tempered flat flexible steel tines, uniformly spaced on a base and handle.

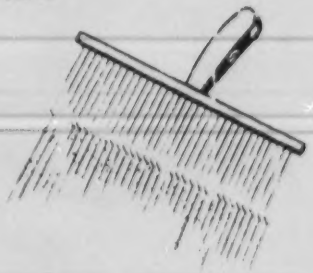


Figure 7. Scarifier

RODS. Several types of rods are used to level freshly plastered surfaces. Rods of 1" x 5 ft wooden board may be used if commercial rods are not available. Commercial rods, shown in figure 8 below, are made of aluminum or magnesium alloy, 5 to 8 feet in length. The browning rods are used to level large flat areas of plaster. The combination rod is used for truing corners and smoothing the finish coat of plaster.

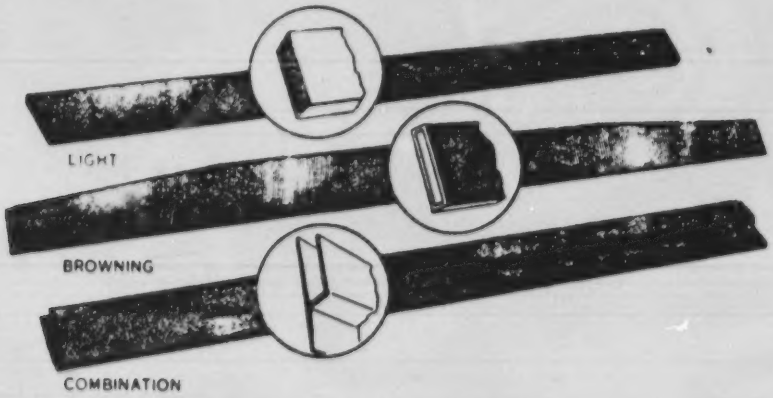


Figure 8. Rods

DARBIES. Long floats, used to eliminate high or low spots in the plaster surface by straightedging or rodding, are called darbies. Darbies, as shown in figure 9, may be flat and flexible, wedged-shaped or channel-shaped. Serrated-edged darbies are used to toughen the surface of plaster undercoats to prepare them for the next coat.

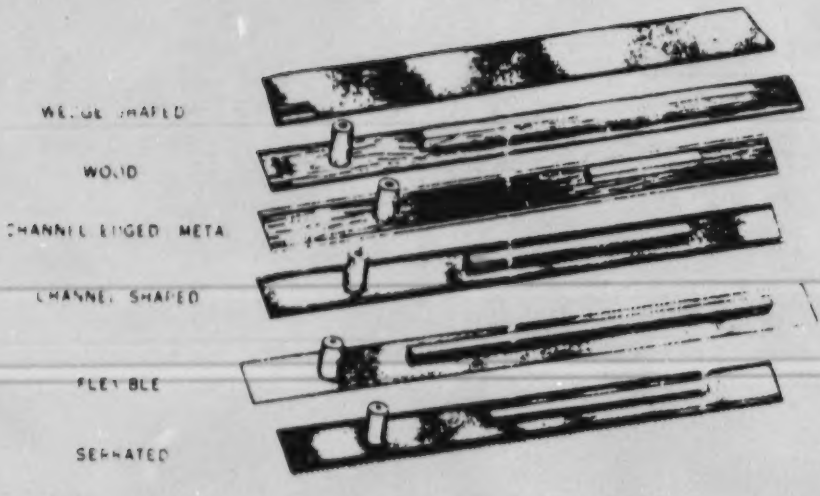


Figure 9. Darbies

SCREEDS AND LEVELS. Screeds used for leveling plastered surfaces are the same as those used for leveling concrete.

Screeds consist of strips of wood placed vertically from the top to the bottoms of the walls. The screeds are adjusted to the thickness required for the scratch coat. Screeds for the brown and finish coats are made of plaster but wood screeds are used as thickness references.

Levels are used to straightedge the plaster surface, using the screeds as edge runners.

APPLICATION PROCEDURES

Laying out and Establishing a Thickness Reference

A mason does not just pick up a glob of plaster and slap it on the wall, hoping it's of the correct thickness. Scratch, brown, and finish coats must be of specified thickness, if a good plaster job is to be achieved. The wall must be sectionalized, and corner beads installed. Screeds must be placed so that the scratch coat is of the proper thickness, developed, and plumbed.

Base screeds are installed along the base of the wall, and another is installed approximately 40 inches above and horizontal with the floor. The screeds provide runners for the straightedging and leveling the scratch coat. The screeds should be set so as to provide a scratch coat of 3/8 to 5/8 inches thick.

Corner beads, both inside and outside, must be installed before the scratch coat is is applied. The beads form the vertical screeds, as well as provide protection against damage.

Preparing Plaster

Plaster is a mixture of several ingredients such as gypsum, lime, lime portland cement, and lime portland cement plaster. There are tables available which give the recommended portions of each ingredient for job mixing. The ingredients should be poured in a dry state through a sieve made of ordinary window screen wire mesh. This will eliminate large pieces of materials. The ingredients must be thoroughly mixed in dry state for 5 minutes in a power mixer. Water is then added until a good mix is attained. A good mix is recognized by its workability and ability to stick to the plaster base.

The ingredients and mixture procedures mentioned above are standard in the preparation of plaster. The quality and amount of each of the ingredients affect the quality of a plaster job.

WATER. Water used for plaster must be clean, fresh and pure. Impure water will not only affect the strength but also the quality of plaster. Too little water in a mix will not make the mix workable. Too much water will thin the mix too much and will not stick to the base. The absorbent capabilities of the base must be considered when determining the amount of water to be added to the mix.

AGGREGATE. Aggregate must be well-graded, clean and free of foreign materials. The aggregate may be sand or lightweight aggregate, which is manufactured. Aggregate adds body to the plaster mix, as well as providing waterproofing, crack resistance and texture qualities to the plaster.

CEMENTING AGENTS. Gypsum, lime, and portland cement plaster are all used as cementing agents. Each has certain qualities which make it a desirable agent. Of all the cementing agents, gypsum is the most widely used.

ADMIXTURES. The basic plaster mix is often supplemented with other materials to add strength and speed, or to retard the setting time or even change color.

Gypsum mortar tends to set too fast. Local weather, weather and aggregate impurities can alter the setting time. One of the most common accelerators used is gypsum, which has been allowed to set and then ground up, and added to the mix itself.

Keene's cement, which contains chemicals such as sulfur of potash, is added to plaster mix to retard setting time.

Fiber or hair is used in the scratch and brown coats to add strength to the plaster. Introduction of new plasters and base materials has reduced this practice, however.

Color pigments may be added to the plaster to change its color. Adding color, however, creates problems in matching, mixing, and application. It is easier to paint the finish coat.

Application of Scratch Coat

When applying the scratch coat, push the plaster through the lath to insure good adhesion as shown in figure 10.

The scratch coat should be between 3/8 and 5/8 inch thick. After applying the scratch coat between two of the base (ground) screeds. Scarify the section before applying plaster to the next section. Continue working in this manner until the scratch coat is applied over the entire area.

Screeding is accomplished by running a straightedge over the screeds. The straightedge will skim mortar from the high points and distribute it into the low points. Additional mortar may be required to fill in the low spots. A scratch coat of uniform thickness can thus be created.

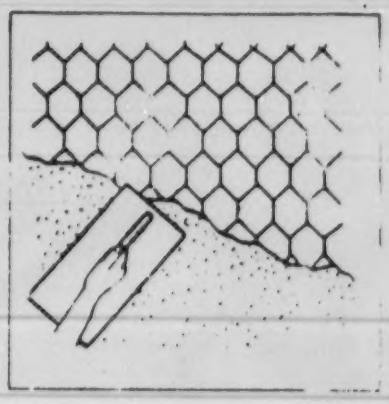


Figure 10. Pushing Plaster through Wire Mesh

The scratch coat must be set semihard so that large chunks of plaster will not be gouged out when scarifying the surface. Scarifying the scratch coat surface provides a rough surface for the brown coat to stick to.

When the scratch coat has hardened sufficiently, usually after 4 or 5 hours at 70°F the screeds for the brown coat can be formed. This consists of forming plaster ridges of desired thickness, usually 3/8 inch, at strategic points over the scratch coat surface.

Application of the Brown Coat

As soon as the plaster screeds are sufficiently hardened to support a straightedge, the brown coat can be applied. The brown coat is applied in the same manner as the scratch coat. It must be leveled and scarified in the same manner as the scratch coat. Like the scratch coat, the brown coat should be hard, but not dry, before forming the screeds for the finish coat. The brown coat should be no less than 1/4 inch thick.

Floating

Various types of floats may be used to create designs or patterns, or even smooth or sandpaper-finish a plaster surface. A more comprehensive discussion on the subject will appear in a later lesson.

Stucco

Plaster applied to exterior walls is called stucco. The plaster mix differs slightly from that used on interior walls -- it must resist water. Portland cement, rather than gypsum, is used since it hardens to a nonporous rocklike surface. Aggregate for stucco can be coarser. The scratch coat can be thicker; however, the brown and finish coats must be closer to the recommended thickness and leveled.

Preparing exterior surface for stuccoing requires the same layout planning and base preparation as required for preparing interior walls. A larger opening in the lath is permissible, due to the coarser aggregate used.

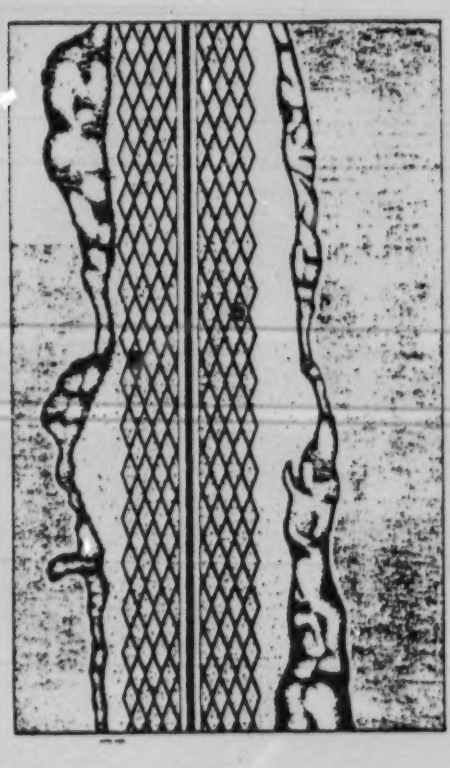


Figure 11

Metal control joints, figure 11, must be attached at strategic points in the wall. These joints are designed to reduce surface damage to the stucco due to structural expansion and contraction.

Application technique for stucco parallel those used in applying plaster to interior walls. Scratch and brown coats may be applied by hand and trowel, or by special machine which sprays the plaster mix. Under certain circumstances, the spraying method may facilitate a complete job in one or two coats.

Curing time for each coat of stucco differs from interior plaster mix due to the cement used. Curing time may range from 3 to 5 days. Atmospheric conditions cause the difference in curing time. In some cases, stucco will have to be dampened at periodic intervals to prevent too rapid drying. Curing time may also vary due to the different type of cement used.

Applying the Finish Coat

Applying the finish coat to exterior plastering job is the same as appying the finish coat to an interior wall. The finish coat should not be less than 1/8 inch thick. A smooth uniform surface is obtained by first leveling the surface by screeding and filling in the low areas. Before applying the finish coat, the brown coat should be dampened to reduce the tendency for it to absorb the moisture too rapidly from the applied finish coat.

Special Effects

The actual finished appearance of the finish coat can be smooth, sandpaper or textured finish, rough or any special design called for or within the imaginative skill of the mason. Stiff brushes, various floats, mastic trowels, jointers, trowels, burlap, wire, rough wood or any material suited for the purpose may be used to create patterns, and designs on the finish coat surface. Special molds may be devised to create brick, block, or flagstone appearing finish. Overlapping circles, random grooves, wood grains, as well as the coarse weave of burlap are just a few of the surface finishes a mason may create. Special materials and dyes may be used to add color effects, or to give the finish a marble appearance.

Figure 12 shows some of the patterns that may be created on a plaster or stucco finish.

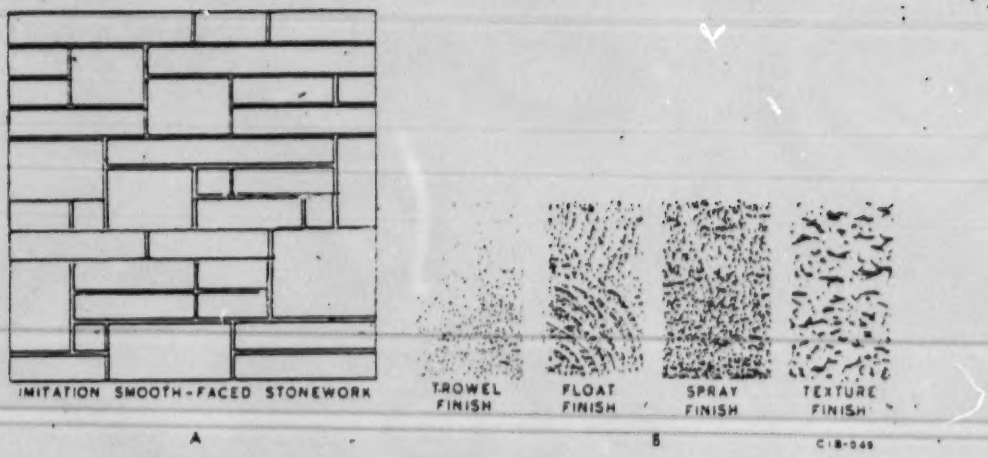


Figure 12

CAUSES OF PLASTER DAMAGE

Errors, committed by carpenters, often contribute to the causes for cracks in plaster. Faulty construction not only weakens the base onto which plaster is applied but will allow excessive movement of the structural members. Faulty construction may cause each a strain on a plastered wall that plaster cracks or breaks away from its base. Improperly sealed walls or roof areas permit moisture to get being the plaster, as well as moisture inside the structure causes plaster to break loose or brack. These conditions a plasterer cannot control; he can only repair the damage caused by them.

The plasterer is not completely innocent of contributing to the failure of damaged plaster. Poor base preparation, incorrect proportions of cement, aggregate, water, poor mixing, as well as improper application, curing and finishing, eventually show up as cracks or chips flaking away from the walls.

Materials improperly screened, improperly proportioned, or improperly mixed, will be considerably weaker than the mix should be. Even though the mix looks good, applies and finishes good, it will eventually fail.

Improperly spaced wooden laths, improperly installed metal lath, or improperly secured lath of any material is bad news. Improperly installed lath will not permit the mortar to properly key itself to the latter. Improperly secured lath may cause large cracks to appear at intersections of lath sections.

Insufficient scarifying of the surface or the inadequate thickness of the scratch or brown coats will eventually affect the quality of the finish coat.

The absence of or improper wetting of the surface, whether it be for the scratch, brown, or finish coat, will result in poor adhesion. This causes the surface to draw moisture from the coat just applied, causing the plaster to set too rapidly.

REPAIR PROCEDURES

Repairing plaster may range from applying a creamy plaster mixture over the crack with a brush to replacing the lath.

Structural Cracks

Cracks which extend either horizontally or vertically through the plaster and up to 1/4 inch wide are known as structural cracks. Such cracks must be cleaned of all loose materials. The crack must then be grooved in a V shape so that the surface opening is narrower than the base. Widen the surface crack sufficiently to enable mortar to be removed from the lath openings. The V groove and the opening in the lath will provide better keying and bonding of the new plaster to the old.

APPLYING PLASTER PATCH. Apply plaster patch in two coats. The first coat is pressed firmly into the lath and crack to near the surface. The second coat is applied when the first coat is nearly dry but not hard. The second coat is the finish coat and should be finished to the same texture as the original plaster.

Map Cracks

Map cracks are less noticeable than structural cracks. They extend through the plaster but do not extend entirely across the plastered surface. The cracks are small lines covering an area from 6 inches in width to several feet in length. This type of crack is usually caused by poor bonding. The cracks are repaired by painting the surface with two coats of gypsum plaster. Holes in plastered surfaces are repaired in the same manner.

Shrinkage Cracks

Shrinkage cracks, while resembling map cracks, are usually confined to the finish coat. Such cracks are caused by too rapid drying on the surface, insufficient troweling, troweling while the surface is too wet, or troweling until the surface becomes too dry. Repair consists of painting the surface with two coats of plaster mix. If the cracks do not take the paint, then it will be necessary to remove the plaster to the lath and build it up to its original surface level. The repair procedure is the same as for repairing holes or structural cracks.

Loose Plaster

Bulging or large cracked areas indicate loose plaster. This condition is caused by broken bond or softened plaster from exposure to excessive moisture. The moisture may originate from a leaking roof, broken or leaking water lines, or leaks in sewer drains. In this case, not only the plaster but also the moisture source must be repaired.

While the moisture source will have to be corrected by another tradesman, the plaster repair must be accomplished by the mason. Remove all the loose plaster and lath, if required (wooden or fiber lath may have been rotted by excess moisture), and rebuild the area to its original level and finish. Each coat should be sufficiently scarified, wetted and finished as any plastering job requires.

Remember that when you repair damaged plaster, you must return the surface to its original appearance. Patch materials should resemble the original ingredients. The finish coat should resemble the original finish of surrounding plaster.

SUMMARY

Plaster is applied in three coats, each requiring a certain thickness, curing and preparation before the next coat is applied.

The plaster itself must be applied over a properly prepared base. The base consists of either wood, metal, or gypsum board lath or properly prepared masonry surface.

While many of the tools you will use to apply plaster are the same ones as you use to apply and level concrete mortar, you will also need a hawk, scarifier, rods, darbies, and screeds.

Plastering requires that sufficient plaster is applied to the scratch coat to insure a good key. The plaster itself must be properly mixed to create a good bond and finish. The scratch coat, as well as the brown coat, must be scarified and sufficiently cured before the next coat is applied. Sufficient plaster must be applied to provide an uniform coat of minimum thickness.

Plastering is the oldest art in the trades. New materials and techniques are constantly adding to the skills and creative abilities of the mason.

Plastering, a term applied to applying a cement - aggregate mix to an interior surface, is called stucco when applied to an external surface. Certain preparations must be made to the wall if plaster is to have a good base.

The aggregate and cement agent differ for inside and outside application. The different ingredients require different curing times.

Scratch, brown and finish coats are normally applied for a full plaster or stucco job.

The finish coat may take on any appearance the mason may desire, or have the time or skill to create.

Repairing cracks in plastered surfaces requires knowledge of the causes of cracks, as well as the skill in actually repairing the crack. Materials used to repair cracks should be the same as the original material. Old materials must be removed to the extent that a good repair job can be accomplished.

QUESTIONS

1. The first coat of plaster is called the _____.
2. The third coat of plaster is called the _____.
3. What is the most common material used for a plaster base?

4. Why is a brown coat the thickest of the three coats of plaster?

5. On what coat of plaster would you use a scarifier?

6. Why would you use a screed when plastering a wall?

7. When would you use furring nails?

8. Exterior plastering is called _____.

9. Gypsum wallboard lath is used on _____ walls.

10. What type of lath is used for exterior plaster?

11. What basic materials are used to make a good plaster mix?

12. What effect do admixtures have on plaster?

13. What procedures insure adequate keying when applying the scratch coat?

14. What is the usual curing time for the scratch coat before the brown coat can be applied?

15. When should the screeds be formed for the brown coat?

16. What is the basic difference between applying the scratch and brown coats?

17. When should the screeds for the finish coat be formed?

18. How important is clean water to a good plaster mix?

19. What is the standard plaster mixing procedure?

20. What indicates a good mix?

21. What are some of the causes for plaster cracking?

22. List the different types of plaster cracks.

23. To what extent should material from a structural cracks be removed to effect a good repair job?

24. What is the proper procedure for repairing map and shrinkage cracks?

25. What corrective action must be taken before repairing plaster that has been loosened by moisture?

26. What materials should be used to repair large cracks and holes?

REFERENCES

CDC 55253, Masonry Specialist

INSTALLING WALL AND FLOOR TILE

OBJECTIVE

Upon completion of this unit of instruction, you will be able to:

- cut, drill, and shape tile to given specifications.
- lay out an area for tile application.
- install wall tile on specified area.
- fill tile joints to a specified depth and clean all excess grout from the finished surface.

INTRODUCTION

From ancient times man has used thin baked clay shapes (tile) to cover other structures. Specimens of tile made in 6000 B.C. exist in museums of the world. Originally, the word "tile," as related to building construction, referred to the baked clay tiles used to cover floors, roofs, walls, and other structures.

Today there are several types of building material used to cover various parts of structures and referred to as tile. In most cases, tile made from products other than clay are identified by placing the type of material before the word "tile." Some of these are aluminum, plastic, asphalt, and acoustic tile.

CLASSIFICATION OF TILE

The ceramic tile industry has adopted a classification for ceramic tile based on the percentage of water the tile will absorb. On this basis there are four classes of tile:

1. Nonvitreous - A tile that will absorb more than 7 percent of its weight in moisture.
2. Semivitreous - A tile that will absorb more than 3 percent, but less than 7 percent, of its weight in moisture.
3. Vitreous - A tile that will absorb less than 3 percent of its weight in moisture.
4. Impervious - A tile that will resist the absorption of moisture.

The semivitreous and nonvitreous tiles must be soaked in water before they are laid to prevent them from absorbing water from the mortar.

TYPES OF TILE

Tiles are made of clay and dried in a kiln. There are many types of tiles available on the market today but the most common that you will be concerned with are glazed tile, quarry tile, and mosaic tile.

Glazed Interior Tile

These nonvitreous tiles are normally 4-1/4 by 4-1/4 inches or 6 by 6 inches square. They are used on walls and floors. Aluminum oxide power is added to glazed tile used on floors to form a nonslip surface.

Glazed Exterior Tile

This is weatherproof tile and is similar to glazed interior tile. The main difference is that this tile has a semivitreous or vitreous body which enables it to withstand severe freezing. It is used for covering fronts of buildings, swimming pools, etc. It is available in the same sizes and shapes as glazed interior tile, and can be obtained in a variety of colors.

Quarry Tile

This impervious type of tile is unglazed and made of a cheaper grade of clay. It is normally in earth colors of orange, red, or brown. Quarry tile is made by the process in which the clay mixture is extruded and the tile is cut to length by means of a wire. The tiles are then fired in a kiln (oven). Quarry tile are usually 1/2 to 1 inch thick and underscored on the bottom. They are laid with a smooth side up and are ideal for use on floors in kitchens, entranceways, etc., where traffic is heavy.

Mosaic Tile

A vitreous tile that is popular for use on floors, bathrooms, shower rooms, counter tops, table tops, etc., is ceramic mosaic. These tiles are small, multicolored squares, rectangles, and other shapes pasted in position on sheets of paper to form a pattern.

SHAPES AND SIZES OF TILE

There are many sizes and shapes of ceramic tile manufactured today; however, there are seven basic shapes of regular 4-1/4 by 4-1/2 - inch ceramic tile, as shown in figure 13. Trim tiles are shown in figure 14.

Tiles with a rounded corner or edge are called bull nose: these tiles are used to form the outer boundaries of the tile area.

TOOLS AND MATERIALS USED TO INSTALL TILE

Cutting and Shaping Ceramic Tile

TILE CUTTER. A machine used for scoring and breaking all types of tile which come within the maximum thickness capacity of the machine. Guides are set on the

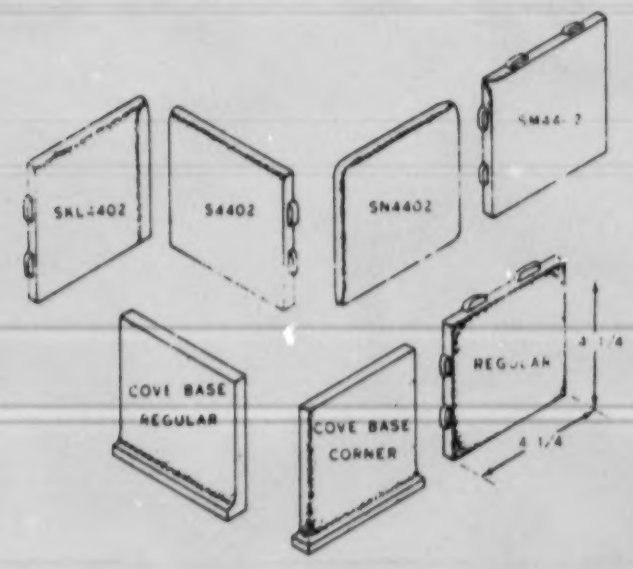


Figure 13

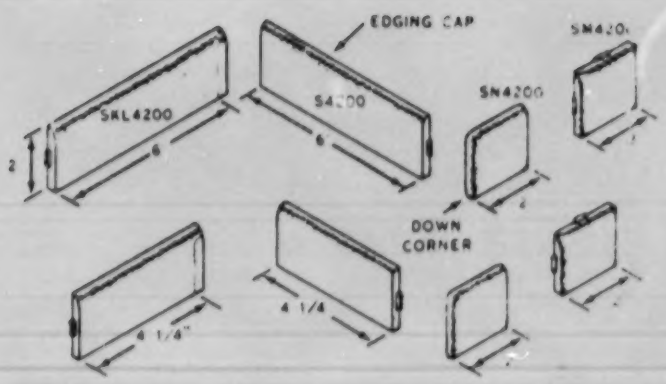


Figure 14

table to determine the length of cut; then tile is scored, as shown in figure 15, by drawing cutter across the tile. After scored handle on cutter is pressed down, tile breaks on the scored mark.

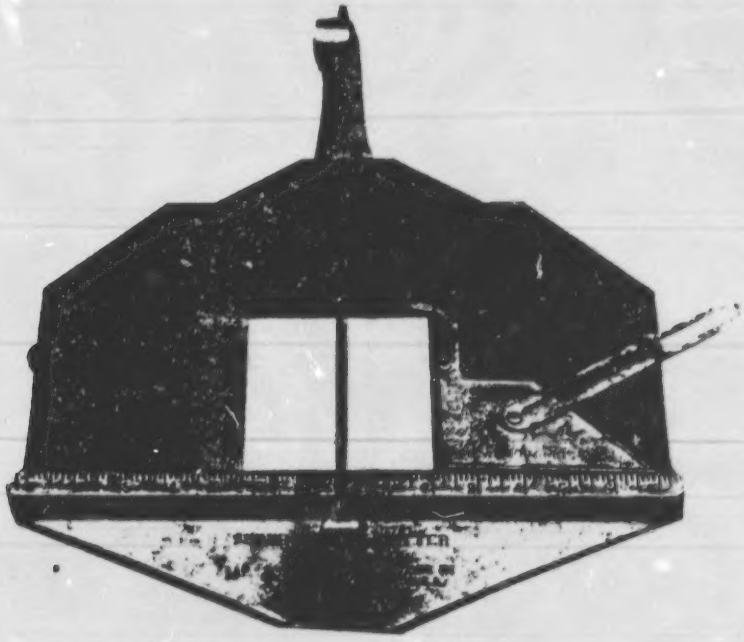


Figure 15. Tile Cutter

TILE CHISELS. Tile chisels are 1/4" wide and 6" long, and are used to remove or cut tile that is placed on setting bed.

TILE SAW. An electric power tool with diamond or abrasive blades. It is used with water as a coolant to cut thick and difficult patterns in tile. It is used to its best advantage when a large number of cuts are involved.

TILE NIPPERS. Nippers are used to cut tile for special fitting at corners, around fixtures, and special designs. There are nippers designed for cutting ceramic tile; others are for cutting wall tile and heavier tiles. The cutters are made of high-grade tool steel. Some are carbide-tipped for longer servce. See figure 16 below.

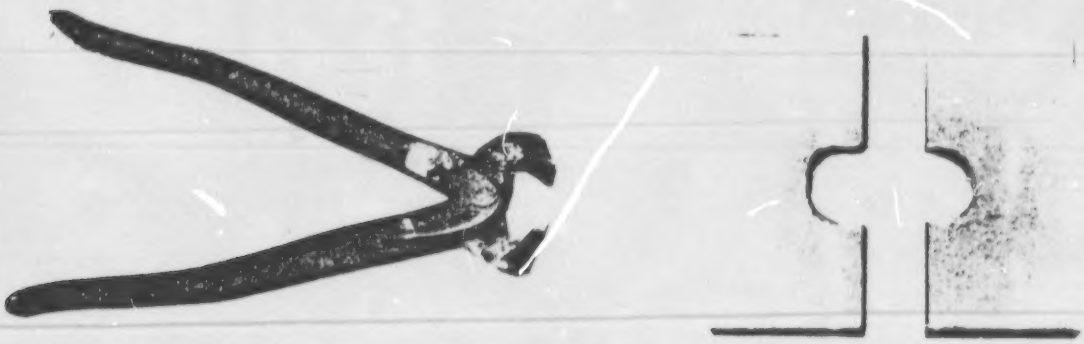


Figure 16

CARBORUNDUM STONE. Carborundum stone (rubbing brick) is 6" x 2" x 1" in size. It can be a fine grit of 150 or vary to a coarse 24 grit. The rubbing brick is used for dressing and smoothing tile.

Materials

The same mastic is used to set tile on horizontal and vertical surfaces. The size of the area to be spread is determined by the setting time of the mastic. Since there are different types of tile adhesive, follow the manufacturer's instructions before using mastics.

Grout seals the joints between the tiles and gives the surface a smooth finish. A good job depends on a clean and neat appearance. There are many colors used in grouting, depending on the color of tile. Do not grout more than you can clean up within setting time of the grout.

Areas subject to moisture should be primed with a nonhardening, waterproofing agent that will not stain or become brittle. This type will remain a good moisture barrier.

On areas subject to freezing, use a frost-resistant mastic and grout. During installation, special care should be taken to fill all voids in setting bed and joints.

DETERMINING TILE REQUIREMENTS

All tile requirements for floors and walls are estimated by the square foot. The number of square feet that is to be covered by tile is determined by multiplying the height by the width of the wall area to be covered. The same technique is applied to the floor area in determining the square footage required to cover the area.

Tile can be obtained in a variety of sizes. The 6-inch square, shown in figure 15, is the basis for the standard sizes of tile. Tile shapes and sizes have been developed by dividing the square into diagonal halves, quarters, and smaller squares as shown in figure 18. Other divisions of the square into oblongs, hexagons, octagons, and other geometrical shapes have brought about the development of still other tile shapes.

Figure 17. Basic 6-Inch Square

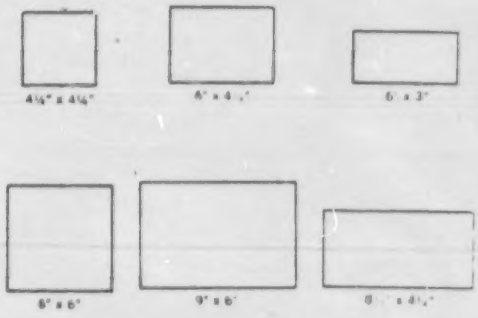


Figure 18. Sizes of Glazed Wall Tiles

When trimmer, base, cap, and similar pieces of tile areused, the lineal or running foot is used as the measuring basis for determining the number of tile required. The number of tile required for any given length, of course, is determined by the length of the tile selected.

FLOOR AND WALL PREPARATION

Tile is normally selected for its ability to resist wear and decorative appearance. The very best material will neither be attractive nor serviceable for very long if pre-installation preparation was not adequate.

Wall or floor surfaces must be free of wax, oil, grease, dirt, and any other matter. That might impair the sticking ability of adhesives applied to their surface. Normally, a good cleaning with either a detergent, trisodium phosphate, solvent, or muriatic acid will be sufficient.

Personnel should take the proper safety precautions when using cleaning agents. Excessive breathing of fumes from some agents may be harmful. Skin burns may also occur if proper precautions are not observed.

Preparing mortar walls for tile installation requires additional effort. The wall itself must be straight. Holes and cracks must be filled with a patch material. The surface can be smoothed by rubbing with a carborundum stone in a circular motion.

USE OF MASTICS

Mastic is the adhesive used to bond the tile to the wall or floor surface. Mastics differ in their composition, depending on the type of tile to be installed. Application techniques, as well as drying time, differ. As a general rule, no more mastic should be applied than what can be covered within the setting time specified by the manufacturer.

In most cases, the mastic is applied with a mastic trowel held at a 50 or 60° angle. Enough adhesive is applied to cover at least 70% of the tile surface. A greater amount of adhesive will squeeze out between the tile. This problem will not exist if the proper trowel and application techniques are used (see figure 19).

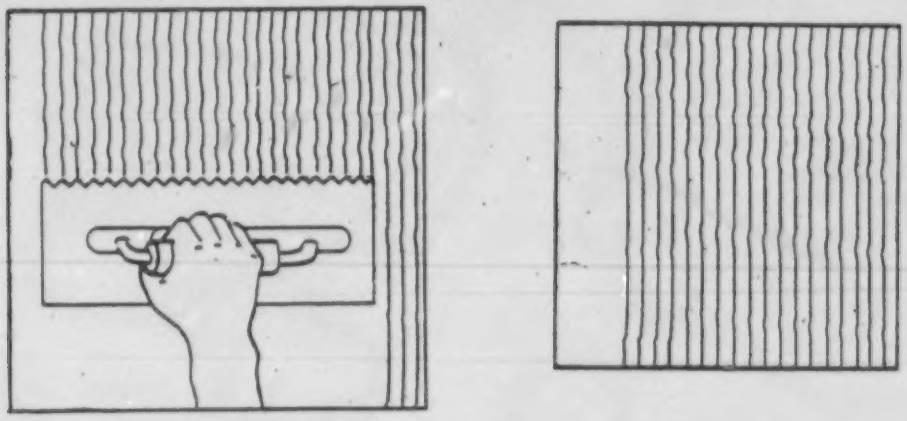


Figure 19. Mastic Trowel and Pattern

Certain precautions should be observed when applying mastics. The fumes given off by the mastics may be injurious to your health if inhaled over long periods of time. The vapors given off are sometimes flammable. Excessive accumulation of such vapors constitute a fire hazard. Adequate ventilation in either case is a mandatory precaution.

INSTALLING TILE

The starting point for installing the tile depends on the type, size, shape of the tile, and the pattern to be created. Manufacturers normally provide a brochure with their products which suggests installation procedures for simple designs. If the suggested designs do not fit the desired design, then a scale plan, identifying the exact position of each tile, will have to be created and followed.

Determine the number of tile required, as well as the patterns required. This is the first step in obtaining the best result from a tile installation.

TILE LAYOUT FOR WALL INSTALLATION

A good tile job, just as any other job the mason does, requires preplanning and preparation. Once it has been established that tiles will be installed, the type of floor tile to be installed must also be determined. Floor tile is normally installed after the wall tile has been installed.

The thickness of the floor tile will affect the height of the first tile course. A spacer of the same thickness of the floor tile is placed under the base cover. The top of the base cove is identified by a mark on the wall. The mark is extended to include the area to be tiled. A level is used to insure a level reference mark as shown in figure 20.

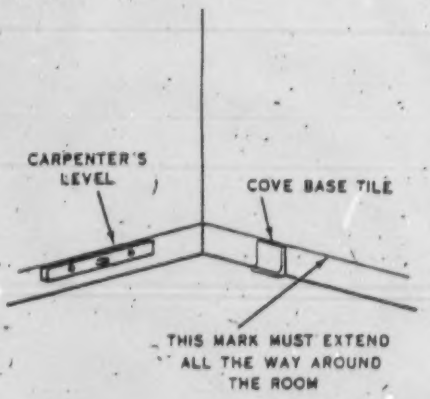


Figure 20

Lay the base cove tile against the wall and insure that the proper space exists between each tile. Use a mason's line, rubber or wooden spacer of the correct thickness. Spacing is no problem with tile having spacing lugs (see figure 21 to left).

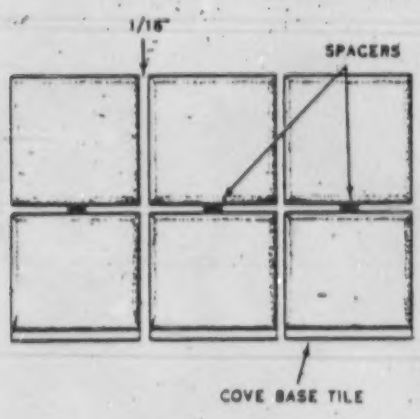


Figure 21

Adjust the tile until the minimum amount of trimming is required. All trimming should be done on the corner tile. When molded corner tiles are used, trim the tile adjacent to it. Never trim formed corner tile.

Once the tile is adjusted, a starting point can be determined. A plumb line is drawn on the wall to identify the vertical edge of the tile. The line represents a point from which each course is started.

A good tile job has straight horizontal and vertical joint lines. Actual laying of the tiles and procedures for maintaining plumb and level joint lines are discussed in a later lesson.

Laying out a floor tile installation must be carried out with the same precision as with wall layout. One wall must be selected to form the base reference. If the adjacent corner walls are square, then they become the longitudinal and lateral base references for the tile. If the corners are not square, then a square reference line must be drawn.

Lay out the first course of tile along each reference line until the most satisfactory position for minimum tile trimming can be attained. Spacing must be considered on floor installation for tile layout. If the tile has no spacing lugs, then improvised items mentioned earlier can be used. A stick or lath may also be marked off and used as shown in figure 22.

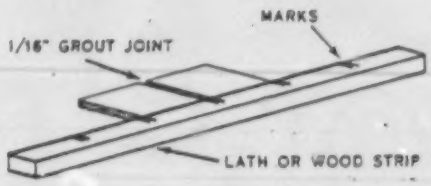


Figure 22

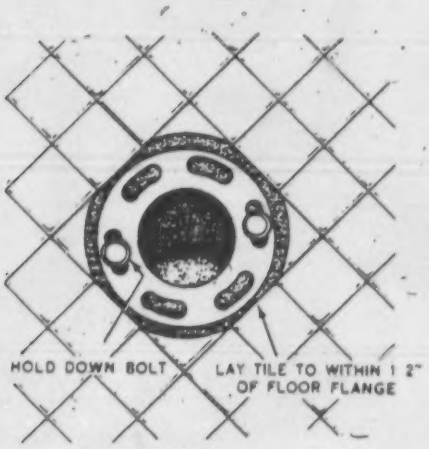


Figure 23

In the case where the fixtures are already installed or cannot be removed, then tile must be trimmed to fit the contours of the fixture. Figure 24 shows how tile might be notched to fit around a pipe, as well as around the fixture.

Whenever tile is installed, there usually is some fixture or other obstacle around or under where tile must be installed. Trimming is often required. Figure 23 illustrates how floor tile is trimmed around a water closet floor flange. The water closet will fit over the tile when installed.

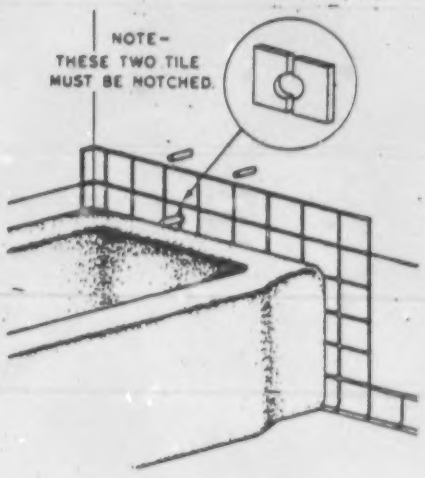


Figure 24

WALL TILE INSTALLATION

Job Layout

Painstaking work on preparing the wall surface for tile installation does not always guarantee a good tile job. Wall tiling is installed from the floor up. The floor, being the base reference for the first row of tile laid, must be level and smooth.

Once the floor surface immediately adjacent to the wall has been properly repaired, further layout of the job can be continued. Place a leveled mark all the way around the room to identify the top of the base cove. The distance from the floor depends on the height of the base cove and the thickness of the floor covering to be installed. Use a carpenter's level to insure level line (see figure 25).

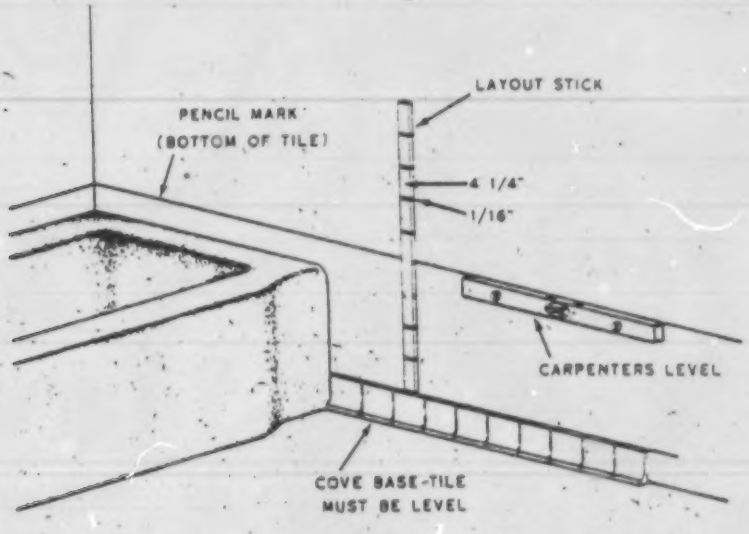


Figure 25

Before applying the mastic, lay the base cove all around the room. This will enable the tile to be cut for a proper corner fit. Do not cut corner tiles. Apply the mastic and install the base cove. The base cove row must be level and each tile properly spaced.

Starting from the center of the wall, install the first row of tile. Again, make sure that the row is level and tiles are properly spaced. Some tiles are equipped with spacing lugs and will present no spacing problems. Otherwise, use the point of a pointer trowel to adjust to adjust the tiles not spaced properly. Rubber spacers, wooden spoons, stirrers of proper thickness, or a mason line may also be inserted as spacers between tiles. Install each row completely the length of the wall, beginning in the center and working toward the corners. The corner tiles may be trimmed to fit. This will keep the tiles in a row plumb even if the corners are not plumb.

Cutting Tile

If all the tile installed were to be installed on a flat surface without obstacles, it would make many tile installers happy. However, water and drain piping, as well as wall-mounted fixtures, window and door frames, provide obstacles to which tile must be trimmed to fit around.

Normally, freehand drawing of the pattern to which the tile is to be cut is adequate since small errors may be covered by grout, caulking, or cover plate. A more accurate pattern can be made by cutting a paper pattern to exact fit and transferring the pattern to the tile. The surface is scored to the desired pattern with a simple glass cutter, as shown in figure 26. The job is completed by using the tile nippers.

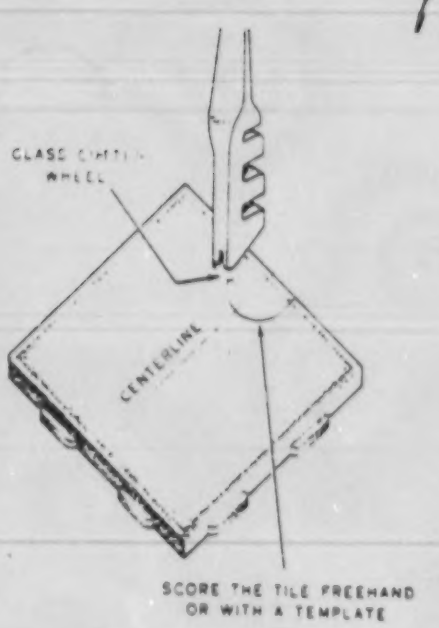


Figure 26

Straight-line cuts on ceramic tile can be accomplished by scoring the surface, aligning the score mark over a pencil or similar item. The pencil must be on a flat surface. Place the palms of the hands on each side of the score mark and apply pressure. The tile will break along the score mark when sufficient pressure is applied.

Mosaic Patterns

Mosaic patterns can be created by placing different colored tiles at preplanned positions when tiling a wall. The pattern can be worked out by covering a floor area with the exact tile members that will be required to cover the wall. The tile and pattern can then be transferred to the wall, one row at a time.

Applying Mastic

Mastic is applied to the wall with a trowel designed to leave small grooves on the mastic surface. Sufficient mastic should be applied to cover at least 70° of the tile surface. Any more than 70° will tend to squeeze out the mastic between the tile joints.

Mastics are composed of toxic and sometimes flammable agents. In either case, adequate ventilation is a mandatory requirement.

Beating in Tile

After tiles are set, they must be beaten into place if a smooth wall surface is to be obtained. Variations in individual tile thickness and depth to which they have been set make it necessary to bring the tiles into a smooth and uniform plane.

To beat the tiles into a smooth surface, hold a block at one end with the flat side toward the tile surface. Move the block over the entire wall surface while striking the block with moderate blows, as shown in figure 27 below.

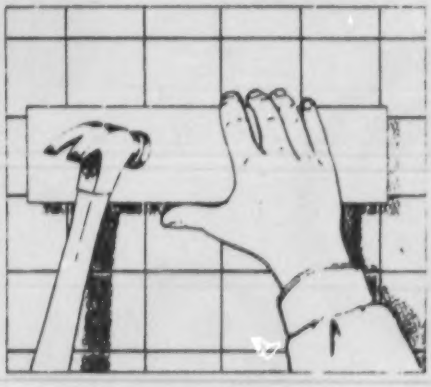


Figure 27

FLOOR TILE INSTALLATION

Floor Preparation

The success of a good tile floor job depends primarily on the type and condition of the floor. Floor tile must have a firm base, or the tile will work loose or crack.

If it is a new construction, that section of the floor to be tiled can be recessed, so concrete not only can be poured to form a firm base but also provide the proper space to bring the floor tile to the same level as the adjacent flooring (see figure 28)..

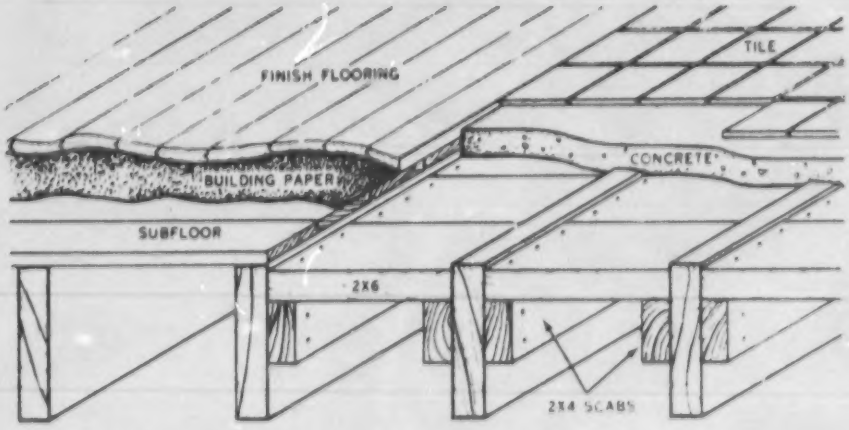


Figure 28. Bathroom Floor Tiling on Concrete Base

On existing construction, the old flooring may be removed down to the subfloor and built up to the appropriate level with plywood, as shown in figure 29.

An alternative method and by far the easiest method of preparing old floors for tiling is to cover the old floor with 1/4" to 3/4" plywood. A prime coat, usually shellac, must be applied to the plywood before the adhesive is applied. This method of floor preparation will raise the level of the finished floor. A determination must be made at this time, whether floor-mounted fixtures will remain in place or they will be raised accordingly. If the former determination is made, then the fixture must be removed and reinstalled after the tile is laid.

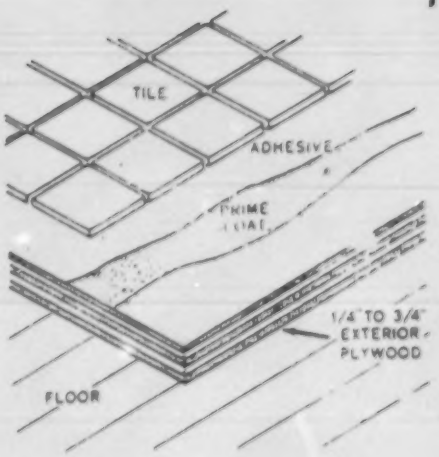


Figure 29. Preparing Wood Floor for Tile

The door and inside frame casing must be trimmed to permit the door to open over the tile. The raised exposed edge of the tile is closed off by installing snub-nosed tile or a marble threshold, as shown in figure 30.

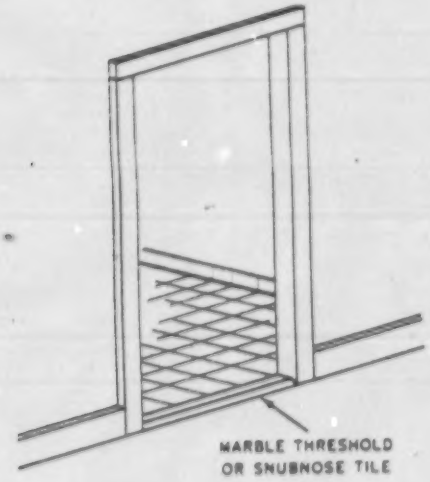


Figure 30. Finishing Doorway with Saddle

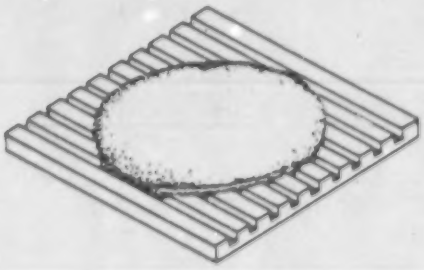


Figure 31. Buttering the Tile

Applying Tile Adhesion

Cement mortar, consisting of 1 part portland cement to 3 parts sand, may be used as an adhesive when laying quarry tile on a concrete base. The concrete slab should be wetted to prevent it from absorbing water from the mortar. The mortar is applied to the back of the tile in small mound, one in each corner and one in the center. An alternate method is to apply a mound to the center of the tile as shown in figure 31. This method is called buttering the tile. Cement mortar should not be used on wooden floor bases.

Mastics are also used as adhesives for quarry tile. The mastics may be applied to either concrete or wooden base. The mastic may be applied to tiles as described above.

Setting the Tile

Preplanning should have identified the side of the room on which trimmed tile is least conspicuous. Set reference lines from which the first row of tile will be aligned with. After butting the tile, set, space, and beat in the tile in the same manner as beating in ceramic tile.

Tile set with mortar should be grouted within 2 or 3 hours after being set to permit a good bond to develop between the cement and grout. Tile set with mastics should be allowed to set for at least 30 minutes before grouting the joints.

FINISHING AND CLEANING TILE

Grouting Ceramic Wall Tile

Grouting tile joints is a messy procedure. It is required, however, to fill the spaces between the tiles. The tile joints are thus sealed and additional is achieved.

Grout consists of white portland cement mixed with water to a creamy paste consistency; it dries to a rock-like finish. It should not be applied; however, until the mastic has set for at least 30 minutes.

While grout is normally white, special dyes are available which can be matched to the color of tile used. The dye and grout should be thoroughly mixed and sifted through regular window screen before adding water. The screen acts as a filter removing all large particles from the grout. The grout should be filtered before mixing with water regardless of whether or not dye is added.

Apply the grout to the tile surface in sufficient quantity to spread over a large area of tile. Work the grout back and forth, up and down, over the joints with a cloth pad or squeegee. Continue this process over the entire tile area until the grout is flush with the tile surface. Remove excess grout from the tile surface. Allow the grout to set at least 20 minutes before starting the cleaning process.

Grouting Floor Tile

Floor tile set with cement mortar on a concrete base should be grouted within 2 or 3 hours after setting so a better bond between the mortar used and grout can be obtained.

Grout used for quarry tile may be mixed with the same ingredients as the mortar used to set the tile or with the white portland cement mentioned before.

The grout mixture consists of one part cement to two and half parts sand mixed to a creamy consistency with pure water.

Apply the grout, using the same techniques as used in grouting ceramic tile. Since the grout consists of sand, a special effort must be made to insure that the joints are properly filled. Use a jointer if necessary to force the grout into the joint. Allow the grout to set for 30 minutes before starting the cleaning process.

CLEANING TILE SURFACES

Whether commercial grout or cement mortar is used to fill tile joints, the final cleaning process is about the same. The grout film over the tile surface may be removed with a damp cloth. The tile is then polished with a dry cloth until the original tile color returns. Care must be taken not to remove an excessive amount of grout from the joints. In its finished state, the grout should be just below the tile surface not to exceed 1/32 inch.

Mortar grouting must be kept damp for 24 hours to permit proper curing and to prevent cracking.

SUMMARY

The term "ceramic tile" can mean many types and shapes of ceramic tile; glazed tile for wall, nonglazed for floors. All walls and floors should be laid out before mastic is applied. Never appy more than you can cover before mastic dries. Cut material should be laid to one side within easy reach. When grouting, make sure all joints are full, neat and clean.

QUESTIONS

1. What is the difference between ceramic wall tile and ceramic floor tile?
2. When making a straight cut, what tool would you use?
3. If you were using nippers, what kind of cut would you be making?
4. When placing a floor, what two types of tile would be used?
5. Where and what is grout used for?
6. what is the most common size of ceramic tile?
7. What are the lugs on ceramic wall tile used for?
8. Where would you use a rubbing stone?
9. When using adhesives, why is it important not to use too much?
10. Why is it important to be able to estimate tile?
11. How is base tile estimated?
12. List preparation required when applying ceramic tile to walls.
13. Why should the base cover installation receive special attention?
14. How is the mastic applied to the wall?
15. What must be done to each row of tile before laying the next row?

16. Where is the best place to trim tile to fit?

17. What is the main purpose for grouting?

18. What may be used as grouting material?

19. How is grout applied?

20. Why should dry grout be sifted through a screen before adding water?

REFERENCES

1. AFM 85-1, Resources and Work Force Management

2. AFM 85-4, Maintenance and Construction Methods for Buildings and Structures

3. AFM 85-25, Guide Specifications for Military Family Housing

4. CDC 55253, Masonry Specialist

3-20 167

WORKBOOKS

3ABR55233-IV-1-P1 thru IV-2-P5

Technical Training

Masonry Specialist

PLASTER, STUCCO, AND TILE

September 1975

USAF SCHOOL OF APPLIED AEROSPACE SCIENCES
Department of Civil Engineering Training
Sheppard Air Force Base, Texas

Designed For ATC Course Use

DO NOT USE ON THE JOB

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This supersedes WBs 3ABR55233-IV-1-P1 thru IV-2-P5, 24 August 1973. (Copies of the superseded publication may be used until the supply is exhausted.)

Dept of Civil Engineering Tng
Sheppard AFB, Texas

WB 3ABR55233-IV-1-P1
September 1975

PREPARING FOR PLASTER OR STUCCO

OBJECTIVE

Upon completion of the workbook you will be able to lay out a lath surface and prepare for plaster or stucco.

EQUIPMENT

	Basis of Issue
SG 3ABR55233-IV-1	1/student
WB 3ABR55233-IV-1-P1	1/student
Pencils	1/student
Paper	1/student
Wire Lath	1/student
Nails	1/student
Screed Boards	1/student
Mason Handtools	1/student

PROCEDURE

Mission I

Working individually but as a member of a four-man team and using the following instructions, lay out a lath surface for plaster or stucco.

1. Obtain necessary tools for installing metal lath. List them.

   _____

2. Secure metal lath with appropriate securing devices.

3. What is the clearance between the metal lath and solid sheathing?

   _____

4. Should both be rigidly secured to building structural members?

   _____

5. What devices are used to control or compensate for structural movement over large stuccoed areas? _____

6. Install such devices if required.

7. What is used to form inside and outside corners for plastered or stuccoed structures? _____

8. Install such devices if required.

9. What can be used to establish thickness of the scratch coat?

_____

10. Install such devices as required or specified.

11. What is used to transport plaster from the mixing trough to the wall area? _____

12. What is used to transfer the plaster to the wall? _____

_____

13. What tools are used to level the plaster surface? _____

_____

14. What tools are used to provide a

a. smooth finish? _____

b. textured finish? _____

15. Clean and store tools.

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MIXING AND APPLYING A SCRATCH COAT

OBJECTIVE

Upon completion of this workbook you will be able to mix and apply a scratch coat of plaster.

EQUIPMENT

	Basis of Issue
SG 3ABR55233-IV-1	1/student
WB 3ABR55233-IV-1-P2	1/student
Pencil	1/student
Paper	1/student
Mortar box	1/12 students
Mixing tools	1/12 students
Plaster materials	1/12 students
Mason hand tools	1/student

PROCEDURE

MISSION I

Working as a member of a four-man team and using the following instructions, mix and apply a scratch coat of plaster.

1. Obtain necessary tools, equipment, and materials required for mixing plaster mortar.

   a. List tools required: _____

   _____

   b. List ingredients of mortar to be mixed: _____

   _____

2. Screen and mix ingredients in proper proportions.

3. Use hawk and trowel; apply plaster to stud mounted lath.

   a. Apply sufficient plaster to key properly on lath.

   b. Apply sufficient plaster to achieve minimum scratch coat thickness.

4. Screed scratch coat.

5. Establish thickness reference for scratch coat.

   NOTE: Allow scratch coat to dry but not harden before building screeds for brown coat.

6. Is the scratch coat sufficiently scarified to provide a good bond for the brown coat? _____

MIXING AND APPLYING A BROWN COAT

OBJECTIVE

Upon completion of this workbook you will be able to mix and apply a brown coat of plaster.

EQUIPMENT

	Basis of Issue
SG 3ABR55233-IV-1	1/student
WB 3ABR55233-IV-1-P3	1/student
Pencil	1/student
paper	1/student
Mortar Box	1/12 students
Mixing tools	1/12 students
Plaster materials	1/12 students
Mason hand tools	1/student

Procedure

MISSION I

Working as a member of a four-man team using the following instructions, mix and apply a brown coat of plaster.

1. Obtain necessary tools, equipment, and materials required for mixing plaster mortar.

   a. List tools required: _____

   _____

   b. List ingredients of mortar to be mixed: _____

   _____

2. Screen and mix ingredients in proper proportions.

3. Mix plaster mortar to cover scratch coat.

4. Use hawk and trowel; apply plaster to scratch coat.

   a. Apply sufficient plaster to properly bond to scratch coat.

   b. Apply sufficient plaster to achieve minimum brown coat thickness.

5. Screed brown coat.

6. Allow brown coat to dry but not harden before building screeds for finish coat.
7. Establish thickness references for finish coat.
8. Scarify brown coat.
9. Clean and store tools and equipment.

MIXING AND APPLYING STUCCO

OBJECTIVE

Upon completion of this workbook you will be able to mix and apply stucco to a prepared surface.

EQUIPMENT

	Basis of Issue
SG 3ABR55233-IV-1	1/student
WB 3ABR55233-IV-1-P4	1/student
Pencil	1/student
Paper	1/student
Mortar box	1/12 students
Mixing tools	1/12 students
Plaster materials	1/12 students
Mason hand tools	1/student

Procedure

MISSION I

Working as a member of a four-man team and using the following instructions, mix and apply stucco to a prepared surface.

1. Determine finish coat, mix ingredients.
2. Determine type of finish coat appearance.
3. Apply finish coat to brown coat in sufficient thickness to permit final textured surface to be created.
   a. Finish coat thickness should not be less than 1/8-inch thick.
   b. Wet brown coat, if required.
4. Use appropriate tools and techniques to create the specified finished appearance.
5. Clean and store tools.

MAINTAINING AND REPAIRING PLASTERED SURFACES

OBJECTIVE

Upon completion of this workbook, you will be able to inspect a plastered surface and identify all damaged areas and make necessary repairs to bring the damaged areas back to their original condition.

EQUIPMENT

	Basis of Issue
SG 3ABR55233-IV-1	1/ student
WB 3ABR55233-IV-1-P5	1/ student
Pencil	1/ student
Paper	1/ student
Mortar box	1/12 students
Mixing tools	1/12 students
Plaster materials	1/12 students
Mason handtools	1/ student

Procedure

MISSION I

Working as a member of a two-man team, inspect aplastered surface and identify all damaged areas.

1. Name the type of damage._____

2. What caused this damage?_____

_____

MISSION II

Working as a member of a two-man team, make necessary repairs to bring the damaged areas back to their original condition.

1. Using appropriate tools, prepare the crack for repair.

2. Determine patch material and ingredient, and mix.

3. Apply and finish the repair surface.

4. Clean and store tools.

CUT, DRILL, AND SHAPE TILE

OBJECTIVE

Upon completion of this workbook you will be able to cut, drill, and shape tile to given specifications.

EQUIPMENT

EQUIPMENT	BASIS OF ISSUE
SG 3ABR55233-IV-2	1/student
WB 3ABR55233-IV-2-P1	1/student
Pencil	1/student
Paper	1/student
Power Tile Saw	1/12 students
Tile Cutter (Manual)	1/4 students
Hand Tile Nippers	1/student
Electric Drill	1/6 students
Mason Handtools	1/student

PROCEDURE

MISSION I

Using both hand and power tools and following given instructions, cut ceramic or quarry tile to half sizes using both the power tile saw and the manually operated tile cutter.

CUTTING TILE WITH A POWER SAW

1. SAFETY PRECAUTIONS

   a. Remove all jewelry.

   b. Keep hands away from saw blade.

   c. Wear goggles while operating saw.

   d. Keep all personnel away from working area.

   e. Keep work area clear of debris.

2. PREOPERATIONAL CHECK

   a. Check oil.

   b. Check tightness of blade.

   c. Check water supply.

   d. Check moving parts for freedom of movement.

3. OPERATIONAL PROCEDURES

a. Mark the tile to be cut.

b. Position the tile.

c. Start the saw.

d. Move the saw slowly through the tile.

4. POST-OPERATIONAL CHECK

a. Shut off engine.

b. Shut off water.

c. Disconnect power supply.

d. Visually inspect saw.

e. Clean the saw

Use the manually operated tile cutter as demonstrated by the instructor.

MISSION II

Using the electric powered drill and a carbide-tipped drill bit, drill a hole in a piece of tile.

DRILLING TILE WITH AN ELECTRIC DRILL

1. SAFETY PRECAUTIONS

a. Remove all jewelry.

b. Wear goggles.

c. Keep work area clean.

d. Keep all personnel clear of work area.

2. PREOPERATIONAL CHECK

a. Check all wiring and ground.

b. Check bit for sharpness.

c. Check bit for size and adaptability with material to be cut.

3. OPERATIONAL PROCEDURES

   a. Locate and mark the position of the hole.

   b. Position the tile.

   c. Drill the hole.

4. POSTOPERATIONAL CHECK

   a. Disconnect power supply.

   b. Visually inspect drill and bit

   c. Clean the drill and work area.

MISSION III

Using the tile nippers, shape a ceramic tile to fit around a water pipe as illustrated in figure 1.

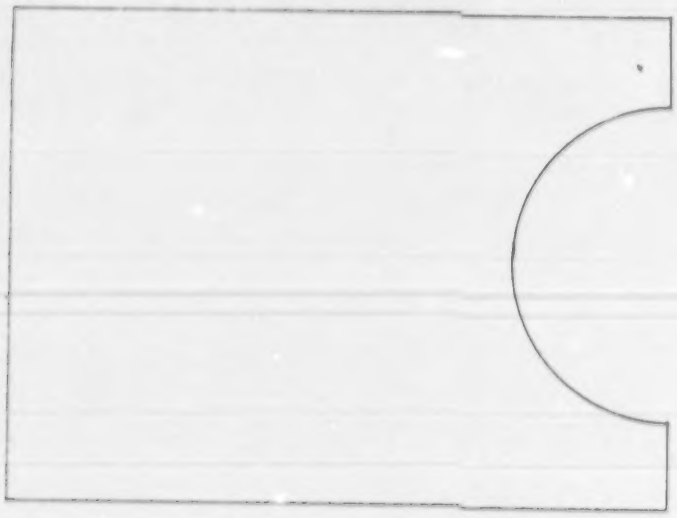

Figure 1. Tile Shaped to Fit Around a Pipe

LAY OUT AN AREA FOR TILE APPLICATION

OBJECTIVE

Upon completion of this workbook, you will be able to lay out an area for tile application.

EQUIPMENT

	Basis of Issue
SG 3ABR55233-IV-2	1/ student
WB 3ABR55233-IV-2-P2	1/ student
Pencil	1/ student
Paper	1/ student
Mason handtools	1/ student

Procedure

MISSION 1

Working as a member of a four-man team and using the following instructions, lay out an area for tile application.

1. Inspect selected surface for holes, cracks, ridges, stains, oil, and waxes.
2. Repair cracks and fill holes with appropriate patch material.
3. Remove stains, oils, waxes with appropriate cleaning agent.

   NOTE: Wear proper protective devices and insure adequate ventilation.

4. Remove high spots and ridges from mortar wall with rubbing brick.
5. Sweep down the surface to remove sand and other loose particles.
6. List the following information:

   a. Total area to be covered is _____ sq. ft.

   b. Size of tile is _____ x _____.

   c. Size of base cove _____ x _____.

   d. Size of cap _____ x _____.

7. Compute the number of ceramic tile required to cover the wall and floor specified by your instructor. Use a piece of scratch paper and record your answers below.

   a. Number of base cove tile _____

b. Number of flat tile _____

c. Number of cap tile _____

d. Number of outside corner tile _____

e. Number of inside corner tile _____

8. Run a level line identifying the top of the base cove (height of the cove plus the floor tile thickness.

9. Run a plumb line to provide a vertical reference.

10. Determine which end of the tile will be trimmed.

INSTALLING WALL TILE

OBJECTIVE

Upon completion of this workbook, you will be able to install wall tile on a specified area.

EQUIPMENT

	Basis of Issue
SG 3ABR55233-IV-2	1/ student
WB 3ABR55233-IV-2-P3	1/ student
Pencil	1/ student
Paper	1/ student
Tile saw	1/12 students
Tile cutter	1/4 students
Mastic trowel	1/4 students
Mason handtools	1/ student
Tile	1/12 students
Mastic	1/12 students

Procedure

MISSION I

Using the following instructions, install wall tile on an area specified by the instructor.

1. Obtain necessary tools for installing ceramic tile. Name them: _____

_____

_____

_____

2. Obtain materials used when laying tile. Name them: _____

_____

_____

_____

3. What is the clearance of the joint when setting tile on a wall? _____

_____

4. What tools are used when cutting tile for a straight, smooth surface?

_____, _____, and _____

5. Name the tools normally used when cutting a hole in the center of a piece of tile for a pipe. _____ or _____ and _____

6. What material, or materials are used to fill in the joints between tile?

_____ or _____

7. Apply mastic.

8. Set base cove to reference line; space tile and level.

9. Set first row of tile.

   Continue tile installation. Check each row for levelness, plumb, and spacing. Trim corner tile to fit.

   Beat in tile to form smooth uniform tile surface. Straighten and space tile.

   Remove mastic which may have smeared over tile surface.

10. Clean tools and work area.

11. Return tools and equipment to the storage area.

INSTALLING FLOOR TILE

OBJECTIVE

Upon completion of this workbook, you will be able to install floor tile on a specified area.

EQUIPMENT

	Basis of Issue
SG 3ABR55233-IV-2	1/ student
WB 3ABR55233-IV-2-P4	1/ student
Pencils	1/ student
Paper	1/ student
Tile saw	1/12 students
Mastic trowel	1/4 students
Mason handtools	1/ student
Tile	1/12 students
Mastic	1/12 students

Procedure

MISSION I

Using the following instructions, install floor tile on an area specified by the instructor.

1. Obtain necessary tools for installing quarry tile.

   Name them: _____

   _____

2. Obtain materials used when laying tile. Name them: _____

   _____

   _____

3. What is the clearance of the joint when laying quarry tile? _____

   _____

4. What material, or materials are used to fill in the joints between tile?

   _____ or _____

INSTALLING QUARRY TILE ON A FLOOR AREA

1. Determine number of tile required to cover the specified area.

2. Clean and prepare surface base.
3. Determine which edge will be trimmed
4. Set reference lines with adjacent walls.
5. Apply adhesive.

   NOTE: Mastic may be applied to the entire base area to be covered. Begin in one of the corners and WORK TOWARD AN EXIT.

   NOTE: If mortar cement is used, properly prepare the tile base.

6. Lay the first row of tile in line with reference mark.
7. Lay succeeding rows, properly spaced and aligned with previously installed tile rows.
8. Beat on the tile to achieve a level and uniform tile surface.
9. Remove excessive mastic that might have smeared over tile surface.
10. Clean tool and work area.
11. Return all tools and equipment to the storage area.

FINISHING AND CLEANING TILE SURFACES

OBJECTIVE

Upon completion of this workbook, you will be able to fill tile joints to a specified depth and clean all excess grout from the polished surface.

EQUIPMENT

	Basis of Issue
SG 3ABR55233-IV-2	1/ student
WB 3ABR55233-IV-2-P5	1/ student
Pencils	1/ student
Paper	1/ student
Mason handtools	1/ student
Rags (polishing)	1/ student
Grout	1/ student

Procedure

MISSION I

Using the following instructions, fill tile joints to a uniformed depth specified by the instructor; and clean all excess grout from the polished surface.

1. Measure the amount of dry grout mix required.
2. Remove large particles from the dry grout mix.

   NOTE: If these particles can be broken up easily between the fingers, they can be used.

3. Sift the grout through a screen.
4. Why is step 3 important?_____
5. Mix the grout to proper consistency.

   a. What is the proper consistency for tile grout?_____

   b. Add the water very slowly to keep from getting the grout too thin.

6. Apply the grout to the tile joints.
7. How do you know when you have enough grout?_____

   _____

8. Allow the grout to dry at least 30 minutes.

9. Remove the grout film. Explain the best method of accomplishing this task.

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10. Polish the tile surface. Explain the best method of accomplishing this task.

11. What additional efforts should be applied to cement mortar joints to insure a good permanent bond?

12. Clean tools and work area.

13. Return all tools and equipment to the storage area.